Fortress

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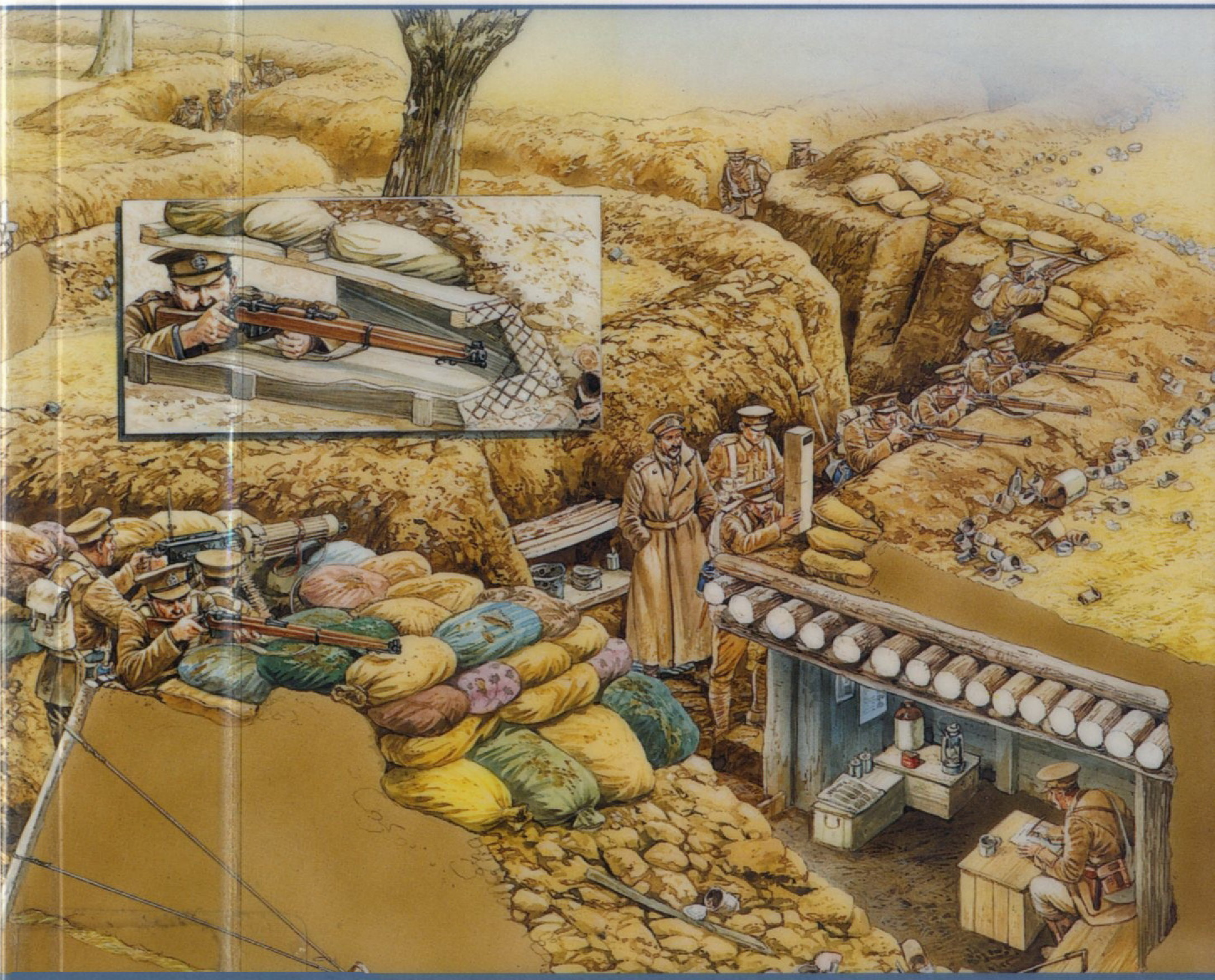
Fortifications of the Western Front 1914–18



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Dedicated to the memory of Colin Fox

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Artist's note

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Introduction

The high explosives revolution and its effect on fortification

By 1914 there had been many major changes in weaponry since the 1860s, of which by far the most important was the replacement of black powder explosives (basic gunpowder) by a whole range of new low and especially high explosives (or HE). These not only enabled artillery to fire at a much greater range than previously, but, pound for pound, allowed each shell to deliver a far larger destructive punch. By about 1900 new recoil systems were also enabling a terrifically high rate of fire without any loss of accuracy.

The field gunners were at first reluctant to exploit their new capability to fire far beyond the position that could be observed directly from their gun sites. It took a long process of re-education for them to adapt to indirect, observed fire from hidden positions far from the enemy. Nevertheless, fire of this type was by far the most destructive element on the World War I battlefield. Not only could it devastate its entire target area within a few minutes, but the victim usually found it incredibly difficult to locate the guns that were doing the firing, let alone destroy them. The artillery could therefore kill without being killed, at least until the complex and specialised arts of long-range counter-battery (CB) fire could be perfected towards the end of the war. In these circumstances an 'artillery duel' normally meant that the artilleries of both sides would be pummelling the long-suffering infantry; but no one very much would be pummelling them. Artillery caused around 60 per cent of the casualties in the war, which means it must have killed a total of around 6 million men. This was many more than the notorious machine guns, whose effect was far more localised in both place and time.

Australians improving poor German trenches at the Maze, Le Barque, on the Somme, 28 February 1917. Contrary to a widespread myth, many of the German trenches, especially those behind the front lines of July 1916, were just as shallow, shoddy and hastily built as the allied ones. The real strength of the fortifications on both sides lay in the dugouts below ground level. (Imperial War Museum, E 210)

Obviously the most urgent priority for infantry was to find counter-measures to HE shelling. Many different approaches were tried, such as dispersion, camouflage, screening and smoke; but as early as September 1914 it was already clear that there was really no substitute for digging. The casualty rate to men in the open was dramatically reduced if only they could throw themselves into even the shallowest ditch, scrape or crater. As soon as this happened there were two clear effects: the first was that – despite many pre-war doctrinal denials – the burrowing infantry would no longer be available for offensive action; and the second was that the artillery tormenting them would need a great deal more guns and shells to scour the area clear of opposition. The battle became a matter of attrition, as an increasingly numerous artillery tried to grind down an infantry force that was increasingly well dug in.

As mobile warfare faltered and died in the autumn of 1914, the two opposing lines became increasingly defined and permanent, and the trenches and dugouts that made up the lines became more elaborate. By the end of 1915 the Western Front could be considered as a series of semi-underground townships, each complete with a vast population and most of the amenities – with the obvious exceptions of safety and comfort – that could be found in the sprawling peacetime boroughs of the Black Country or the Ruhr. The population even included quite large numbers of women, most of them honest, very close behind the lines, although admittedly the gender ratio was unnaturally skewed heavily in favour of the males.

The strategy of the allies was essentially offensive, and their generals were worried that too much fortification would dull the aggressive edge of their troops. The Germans, by contrast, were concentrating most of their offensives on the Eastern Front and, apart from their attack on Verdun, were almost entirely defensive in the west until the spring of 1918. This gave them an incentive to continue perfecting their art of fortification almost to the end of the war. Already in the battle of the Somme in 1916 it was found that the German front trenches were better built, and their dugouts deeper and better protected, than the British ones – although admittedly the rearward lines were still often shallow and poorly built. In their 1917 spring retreat the Germans added booby traps to the mix; then at Ypres they used innundations and concrete pillboxes in depth, while at Bullecourt and Cambrai the Hindenburg Line featured some amazingly dense hedges of barbed wire. Finally, by 1918, it had become routine for the Germans to include such novelties as anti-tank mines and guns in their defences.

The better the fortifications became, the harder it was to attack them. Whereas in 1914 a relatively small amount of artillery had been able to destroy all opposition in any given area, by 1917 it needed an incredibly large amount. Even then the object could no longer be to 'destroy' the enemy, but only to 'neutralise' him for long enough to allow friendly infantry to occupy the ground. This could sometimes be done very effectively, as it was in the initial British assaults on Arras, Messines and Cambrai in 1917; or in four of the German spring offensives in 1918. Nevertheless, such results were very difficult and laborious to organise, and it was still more difficult to bring forward the guns over broken ground to convert success on the first day into a further attack on the second. For most of the time, along most of the Westen Front, major assaults could not be attempted. Despite the awesome power of an attacker's artillery, therefore, it was the fortifications and their defensive artillery that generally enjoyed the upper hand. This combination ensured that for most of the time the two sides sat and glowered at each other across no man's land. Successful offensives on the Western Front would be few and very costly, so that the war as a whole would forever be remembered for its indecisiveness, immobility and sickening sense of futility.

A walk along the Western Front from Nieuport to Belfort

After the initial allied retreat in August 1914, then the Marne counter-attack and the 'race to the sea', the Western Front became established on essentially the line it would occupy until early 1917. Two years of insistent allied battering then persuaded the Germans to make a deliberate withdrawal along about 18 per cent of their frontage, to a shorter but stronger segment of line in their 'Hindenburg Position' covering Cambrai and St Quentin. They held this line defensively until their major advances in the spring of 1918, after which the allies made still more dramatic counter-advances from July to the end of the war on 11 November.

Thick wire in the Hindenburg Line at Masnières. (Imperial War Museum, E 3583)

The 'old Western Front' of 1915 and 1916 ran from Nieuport, where the river Yser flows into the North Sea, inland through low-lying and badly drained clay land to the Ypres salient, which the British held throughout the war. Then it struck south through Messines and Armentières to Loos, still in the 'traditional' British sector, and on around the western side of Lens to the chalk of Vimy Ridge and Arras – an area which had originally been held by the French, but which was taken over by the rapidly expanding BEF in late 1915. From Arras the line went south again to the epic Anglo-French Somme battlefield of 1916, between Albert and Bapaume, then across the river Somme west of Péronne to skirt around the western side of Noyon, just north of Compiègne. After that it turned sharply eastwards to join the line of the river Aisne around Soissons, putting the Germans into a clear salient at Noyon, which the French tried to pinch out in 1915–16, but which the Germans abandoned in 1917 during their retreat to the Hindenburg Line. French efforts in this area would then be expended against the long and deadly ridge of the *Chemin des Dames*, running from Soissons to Berry au Bac. The line then crossed to the south bank of the Aisne to run north of Reims eastwards through the open fields of Champagne to the hilly and wooded Argonne, after which it skirted around the north and east of the irreducible French salient of Verdun. It then drove south down the river Meuse to turn just as suddenly east around the Germans' St Mihiel salient, although after that its progress became much less dramatic through the more open fields of Lorraine. It crossed the river Moselle north of Nancy and then shadowed the line of the river Meurthe some distance to its north. Finally the Western Front turned due south along the 'blue line of the Vosges' to the Swiss border just south of Belfort: a craggy region of rocky mountains and steep,

thickly forested slopes. The sector between Nancy and Belfort was normally very 'quiet' by the standards of the Western Front as a whole, although it did occasionally erupt into localised battles that were every bit as intense and costly as anything seen at Craonne or Passchendaele.

Map of the Western Front, including the Hindenburg fall-back position and the siting of the pre-war forts. (© Copyright Osprey Publishing Ltd)

Chronology

1871–1914
Many fortresses built to defend both sides of the new frontier between France and the German-occupied provinces of Alsace and Lorraine, including the German '*festen*'.

1885–86
Aerial Torpedo crisis: HE shells are perceived as a major threat to extant fortifications. Fort La Malmaison (south-west of Laon) used as a test target for new French HE (Melinite) shells: it fails the test – so major additional protection is needed for selected forts at key sites.

1914
August: outbreak of war; reduction of the Belgian fortresses and deep German advances into northern France that were halted on the Marne.
September: the 'race to the sea' and the start of serious problems for the offensive: the Western Front is laid out more or less where it will remain until 1918.

1915
The year of deadlock and the disorganised improvisation of completely new tactics: mostly for defence, but also for attack. Many futile battles.
10 March: Neuve Chapelle – an innovative British artillery attack stimulates more German depth defence.
22 April: Gas first used in the second battle of Ypres.
9 May: Laffargue starts the concept of stormtroop tactics, at Neuville St Vaast.

1916:
21 February: 10-month battle of Verdun begins, leading to the sagas of forts Douaumont and Vaux.
1 July: The Somme starts – the Germans have a fully prepared battlefield, but they soon realise the weaknesses of their old ways and increasingly look to ever greater 'depth'.

1917
23 February–5 April: Germans shorten their line by stepping back to the pre-prepared Hindenburg system along some parts of the Western Front.
16 April–9 May: Triumph of German depth defences against the Nivelle Offensive on the *Chemin des Dames*; but rather less success against newly co-ordinated British assault methods at Arras (9 April–16 May) and Messines (7–14 June).
July–November: Germans try successive new formulae for depth defence at Third Ypres, including widespread use of concrete structures.
November: Hindenburg Line breached at Cambrai – then the power of infantry counter-attack restores most of the lost ground.

1918
21 March: German offensives begin: show how little the British understand depth defence.
11 June: German offensives encounter French counter-attacks.
8 August: British offensives start at Amiens against improvised German defences.
September: British breach the Hindenburg Line. US offensive against the St Mihiel forts.

Operational history

1914: the Belgian fortresses, the surprising power of super-heavy artillery, and the still more surprising power of improvised field fortification

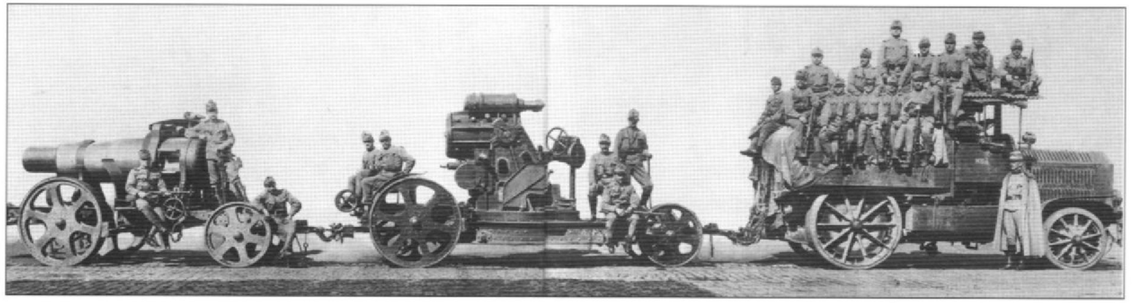
The Western Front was opened when the Germans attacked Luxembourg on 2 August 1914, and Belgium the following day, according to their great Schlieffen Plan that they had been plotting and perfecting for almost two decades. Among other things, Schlieffen had been anxious to avoid making a frontal attack on the impressive chain of modern frontier fortresses that blocked the direct path into north-east France in the area between Verdun and Belfort. These fearsome bulwarks had originally been planned after 1871, mainly by the great engineer General Serré de Rivières, and some of them had been upgraded successively as technology advanced. The Germans' assessment was therefore that, when compared with a frontal assault upon those fortresses, the diplomatic sin of breaking Belgian neutrality represented very much the lesser of two evils. However, the Belgians also had their own brilliant fortress-builder, in the shape of General Henri Alexis Brialmont. He had laid out rings of fortification around Antwerp, Liège and Namur that had originally been no less modern than those to be found on the French side of the Ardennes. The German leadership did not expect the Belgians to offer any resistance at all; but the reality in 1914 was that the new King Albert was defiant. His fortresses would indeed try to block the German advance, and they promised to negate the Schlieffen Plan completely. If they had succeeded, it is possible that this particular world war would have fizzled out very quickly indeed.

For every new type of fortress, however, a new means of attack would eventually be designed. In this case the Germans had some excellent heavy 210mm howitzers, which from 5 to 16 August pounded the key fortress of Liège into submission within a quite unexpectedly short space of time (see table) in an operation which incidentally rocketed a certain Colonel Ludendorff to the fame and glory that would give him the supreme command in the west as early as August 1916.

The shells came crashing through the thick concrete roof of enough of the 12 ring forts to cause a general collapse of resistance. They exploded with devastating effect inside the garrison's living quarters, numbing the survivors with the concussion and choking them with swirling, blinding dust. As if that were not enough the Germans then produced an even higher trump card, in the shape of new super-heavy siege artillery: the Krupp 420mm 'Big Berthas' or 'Gamma guns', and the Skoda 305mm 'Skinny Emmas' or 'Beta guns'. All the forts at Namur and Antwerp were attacked with 420 or 305mm projectiles, and they also fell in short order. For a heady moment it looked as though all Schlieffen's fears about the power of modern fortification had been misplaced, and

Fire needed to reduce the Belgian forts in 1914. *(Details from Rocolle)*

Area	Days each fort held out	Calibres of siege guns (mm)
Liège	1	210
	2	210
	1	210
	3	210
	4	210 then 420
	under 1	210
	1	210
	under 1	210 + 420
	1	no bombardment
	1	no bombardment
Namur	2	210 + 420
	2	210 + 420
	3	210 + 305
	1	305
	under 1	305
	1	420
	1	no bombardment
	1	no bombardment
	1	no bombardment
Antwerp	9	420
	7	305 + 420
	5	420
	5	305 + 420
	30	305 + 420
	5	305
Maubeuge (French)	8	210
	6	210 + 305
	6	210 + 305
	7	no bombardment
	8	420
	8	420
	8	no bombardment



ABOVE A 'Skinny Emma' Austrian 305mm fort-busting siege mortar in the travelling mode. These guns performed great feats in helping to destroy the Belgian and Maubeuge forts in 1914, and would see much action again at Verdun in 1916. (*The Illustrated War News*, 1914)

RIGHT A destroyed cupola at Fort Loncin at Liège, after only a short bombardment by the German heavy artillery in August 1914. (*The Illustrated War News*, 1914)

that the German offensive would be completely unstoppable. This seemed to be doubly true when the defeat of the Belgian forces was followed by that of five French and one British armies in short order in the 'battle of the frontiers' between 20 and 25 August. At Charleroi the French Fifth Army was able to hold its positions for only three days in the face of heavy shelling, while at Mons the British were outflanked and forced to retire after only 12 hours. Still the Germans advanced, and still they were able to capture forts at Lille and Maubeuge apparently at will, and then the particularly modern Fort Manonviller in Lorraine on 27 August. Nor was the German advance finally halted on the Marne by the tactical power of the defence, but rather by skilled French re-deployments combined with German mistakes at the operational level.

Where the tactical defensive really came into its own was in 'the race to the sea' as both sides staked out long frontages with relatively small numbers of men. After just a few hours' improvised entrenchment these thin screens often proved capable of unexpectedly robust, albeit still very costly, resistance. First the Germans took up positions along the *Chemin des Dames* on the north bank of the river Aisne which they would hold until 1918. Then the allies outflanked them to the west, to be met in turn by more German lines, which eventually reached the sea just north of the Belgian border in mid-October. Finally, the Germans attempted a series of counter-attacks on the northern end of the line, from 20 October to 24 November, which would become known as the battle of First Ypres. The Belgians on the left flank fought well and retired under the cover of innundations, while the British on the right, around Ypres itself, managed to hold their positions by desperate expedients, despite three potential German breakthroughs. Every man who could be scraped together was thrown into the cauldron, protected by the flimsiest of fieldworks and with all too scant training in the essentials of modern tactics. Nevertheless, the

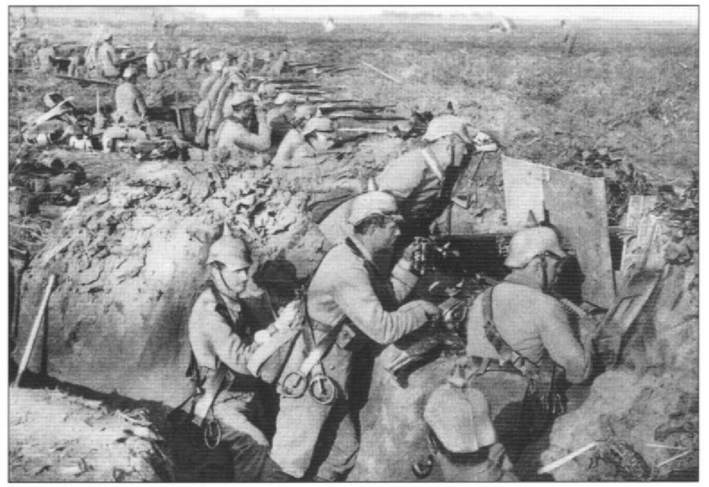
Naive British troops in October 1914 in a nicely narrow trench that is well built with regulation parapet and parados more than covering a standing man, and with no enemy threat in sight. However, it is a death trap by reason of its overcrowding and almost complete lack of traverses – nor do there seem to be either firesteps to allow the men to use their rifles, or revetments to prevent the walls crumbling in rain. (*The Illustrated War News*, 1914)

allied line held firm and General Haig won the fame and glory that would secure him command of the whole BEF as early as September 1915.

1915: the year of deadlock

As the armies settled down to trench warfare, they rapidly discovered that their pre-war ideas about field fortification were outdated in many important respects. In the first place they could not afford to pack men into the front line in the old 'shoulder to shoulder' manner: not only because the frontages were now so long that they could be held only if the manpower was spread very thinly, but especially because modern artillery made it suicidal to bunch together, even when protected by earthworks. A single lucky shell could wipe out all the inhabitants of any given section of trench, so a strict system of zigzags and 'traverses' had to be introduced to ensure that each trench section was short enough to be held by at most only one man. For the same reason it was quickly appreciated that not even the best-built trench was sufficient for full protection. Shell-proof underground dugouts became absolutely essential for security, and their construction came to be given a much higher priority than the trenches themselves.

Secondly, barbed wire turned out to be of enormous importance in strengthening any defensive position, and tens of thousands of miles of it began to be strung out all along the front. Wiring parties would venture forward into no man's land every night to hammer in wood or metal pickets – or more silently to screw in specially designed steel ones – and then connect them together with reels of wire, making it far harder for an attacker to reach the defended trenches without revealing his presence. Less obvious, but equally voracious of engineer stores, was the massive use of telephone cable, to link the front trenches to their commanders at battalion and brigade HQs, and then to higher headquarters all the way back up the chain of command to the army chief of staff and his vastly proliferating logistic agencies.



Naive German troops in October 1914, hopelessly overcrowded in a trench that does at least have traverses and good firing positions, but which appears to be too shallow to conceal a standing man, and seems to lack a parados. Note the steel loophole shielding the machine gun: similar loopholes would be a common item of German trench furniture through much of the war. (*The Illustrated War News*, 1914)

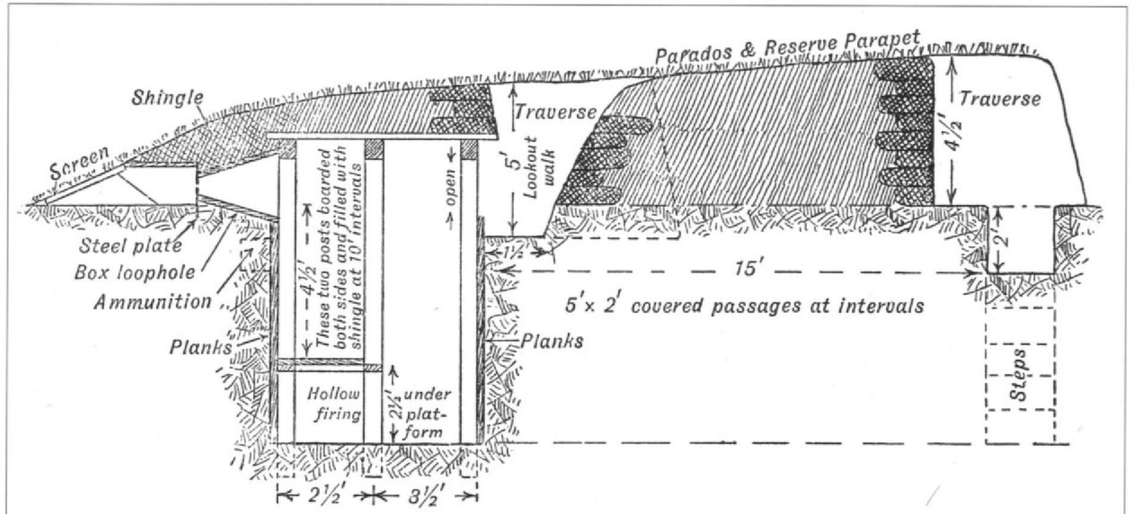


Fig. 51.—Deep Fire-Trench with Overhead Cover, and Reserve Parapet for Use when Overhead Cover is broken.

Deep fire trench with overhead cover. In 1914 there was a belief in the British army that the only overhead cover required was a relatively shallow covering (9–12in.) to absorb shrapnel. The shock of battle soon showed this to be not only unrealistic but positively damaging, since the debris from collapsing roofs would often block the trench to traffic. Only much thicker overhead cover was useful against HE shells. (The Museum of Lancashire: Solano manual, 1914 – p. 92, Fig. 51)

Thirdly, it soon became clear that the pre-war armies had been equipped mainly with direct-fire weapons for warfare in the open – light field guns, machine guns, rifles and bayonets – rather than with the type of indirect-fire weapons that were really needed to fight in trenches. For trench warfare the requirement was for HE munitions that could be made to fall into the enemy's positions vertically from above, to explode below ground level in the places that could not be reached by horizontally flying or 'grazing' bullets. Howitzers were ideal for this new requirement, and it was unfortunate for the allies that in 1914–16 the Germans enjoyed a great numerical lead in that particular department. Trench mortars represented a smaller but novel version of the howitzer, and all armies had to improvise their own new designs during the course of 1915, sometimes using such primitive expedients as elastic band catapults or medieval-style trebuchets. At a level below that there was also a need for rifle- and hand-grenades that could be used by individual infantrymen. Once again, few suitable munitions were readily available on the inventory, so new ones had to be created during the year. It would be only in 1916 that fully combat-proven and soldier-proof mortars and grenades (or 'bombs') would be available to all.

Fourthly, and perhaps less obviously to the generals of 1915, the need for defence in depth gradually came to be appreciated. Despite the very many bloody defeats suffered by attacking forces, it remained a fact that absolutely any trench, no matter how well built or armed, could always be captured if the assailant was sufficiently well prepared, determined and organised for the task. The rapid German advance through Belgium had shown that even fixed masonry fortresses could be taken quickly, provided the attacker was appropriately armed; and in late 1914 and 1915 it turned out that the same also applied to field fortifications. At Neuve Chapelle on 10 March the British achieved a near-breakthrough, albeit on a short frontage, using an especially heavy 'hurricane bombardment' with artillery to destroy the enemy front line trenches before the infantry moved into them. At Second Ypres on 22 April the Germans made a small but spectacularly successful attack with poison gas, adding yet another category of weaponry to the fast-expanding inventory. Then the French Captain Laffargue was able to demonstrate great initial success in May at Neuville St Vaast, using only infantry equipped with a suitable mix

Gordon Highlanders carrying wire at Tilloy les Mofflaines, May 1917. Note the methods of carrying and deploying it. (Imperial War Museum, Q 5230)

of the new generation of man-portable weapons, although even he – and later the rest of his brigade – was eventually halted by just two machine guns located in depth. The manual that he wrote as a result of this experience (translated by the British as CDS 333 in December 1915) was circulated in every army and can be hailed as the basis of what would later be called 'storm troop tactics'.

Since they knew that no trench was really secure from capture by a well-prepared assault, every general who wanted to make an attack was naturally encouraged to believe that offensive warfare was still perfectly possible: and all too many lives would be lost in pursuit of this belief. The problem, however, was that the generals who wanted to defend – and usually they were Germans – quickly realised that it was essential to build a second system of trenches a mile or two behind the first system, so that even if the first line were captured, the attacker would not be able to break through to the defender's rear areas. In other words a break-in should not be converted into a break-out. There was no break-out at Neuve Chapelle, Second Ypres or Neuville St Vaast, nor on many other battlefields besides, simply because the act of capturing an enemy's front line completely disrupted the attacker's communications and artillery support. Hence all attempts by the attacker to improvise an immediate second bound forward could be countered by an even more immediate second line of resistance improvised by the defender. The result was that by the end of 1915 a second line of defence, and sometimes a third and even fourth, had become standard along the whole of the Western Front.

1916: the year of Verdun and the Somme

In February 1916 the Germans launched a carefully planned offensive against Verdun, which encountered two distinct layers of defences. In the front line there was a system of fieldworks that had been built to a high standard in 1915, including some early concrete shelters. Resistance continued for some time along this line, but so powerful was the German assault, especially in terms of artillery, that the front eventually succumbed. Behind it lay the fixed pre-war forts, some of which had been almost 'state-of-the-art' in 1914, and capable of resisting even the now-ageing super-heavy howitzers that had reduced Liège and Namur. Unfortunately by 1916 these forts had largely been stripped of their garrisons, and even much of their artillery, due to the pressing needs of the front line. Thus

Colonel Driant's HQ bunker at Verdun, which would be a surprisingly early example of an 'improvised' concrete fieldwork, had it not been pre-planned as a part of the highly sophisticated system of defences to support the main pre-war forts. Driant himself had been a celebrity of the French extreme political right before the war, and his death in the February 1916 fighting quickly achieved iconic status among 'patriots'. (Paddy Griffith)

The author stands on the counter-scarp of one of the forts on Bois Bourrus ridge at Verdun, 1965. The undergrowth was already very thick then: it has become much more so during the intervening 40 years. (Paddy Griffith)

is was that just nine German infantrymen, who had fought their way through the advanced fieldworks, were able to wander unopposed into Douaumont, 'the strongest fort in the world', on 25 February. Douaumont had been all but undefended, and in German hands it would quickly become a stalwart bastion against French counter-attacks. The second and last of the Verdun forts to fall was the considerably smaller Fort Vaux; but in that case the French had been forewarned and were able to put up a ferocious resistance – mainly in gas-filled, lightless underground tunnels – which lasted for almost a week, from 2 to 7 June. It was an epic of defensive warfare that would inspire the post-war Minister of War, the ex-sergeant André Maginot, to build the ultra-modern fortified line along the whole Franco-German frontier that would forever bear his name.

After the German impetus had been halted, the initiative passed to the now numerous, but still inexperienced, British on the Somme from 1 July onwards, and then eventually to the French at Verdun, who began to counter-attack on 19 October. What the British encountered was a system of fieldworks that was even stronger than any that had so far been seen. Not only were they laid out in depth, all the way back up the slope from the original front line, in low ground, to the overwatching features of High Wood and Delville Wood, but each line of German trenches was dotted with deep shelters, or *Hangstellung*, often well over 20ft below ground level. Large numbers of troops could rest within them in complete security from all but the very heaviest shells, whereas at only 6 or 8ft deep the trenches and light shelters on the surface were always vulnerable to artillery and trench mortars. They would be very thinly held, and usually very poorly maintained in normal times. At moments of crisis, however, a seemingly endless file of fresh troops could emerge from their deep shelters to strengthen a threatened point, or launch counter-attacks. At first the allied troops were awed and bewildered by the presence of these unexpected German reinforcements and then, once the secrets of the deep dugouts had been uncovered, they allegedly became angered that their own engineers had not provided them with similarly secure accommodation.

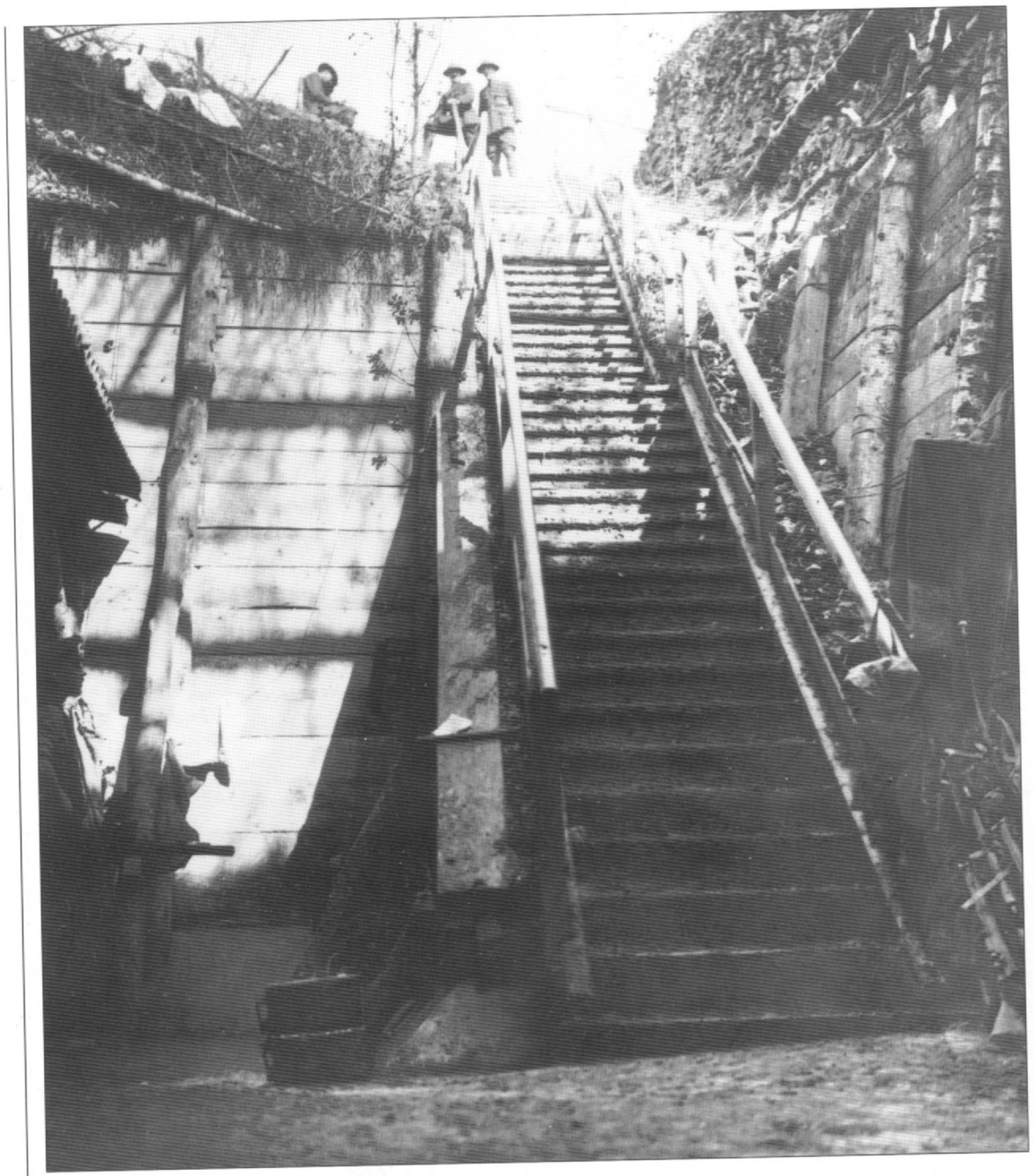
On the flank of the glacis of Fort Vaux, Verdun: a steel observation turret peers over its massive concrete mounting, with the remains of a wrecked twin 75mm gun cupola to the left and in front. (Paddy Griffith)

It soon became clear on the Somme that this new generation of German defences could not be physically destroyed by shell fire, as they had been at Neuve Chapelle, since there simply were not enough guns available to bring down a sufficient weight of HE per square yard. Instead, it was realised that the best tactic was to use artillery merely to neutralise the German defenders for the relatively short period needed for attacking infantry to get in among them. This concept became crystallised as the 'creeping barrage', which had been poorly understood on 1 July, but which was being used widely from 14 July onwards. As it developed in late 1916 through 1917 the mature British creeping barrage would become a fearsome weapon indeed, with up to seven successive lines of bursting shells, mortar bombs and machine-gun barrages, ranged up to one and a half miles in depth, advancing regularly by 100 yards every four minutes in step with the advance of the infantry line. The aim was to make it so dangerous for a defending infantryman to raise his head above the parapet that he would prefer to stay sheltered in underground burrows. He would then be unable to bring fire to bear against attacking infantry until it was too late.

By the end of the Somme battle in November, the Germans had been forced to build no less than seven successive defensive lines in depth, which had eventually stymied all of the many attempted breakthroughs to Bapaume, whether by infantry, cavalry or even, on 15 September, by tanks. It still remained true that a well-organised and well-prepared attacker could always capture the first line of trenches – especially when he was following a creeping barrage, and using Laffargue-style platoon tactics whenever the barrage broke down. However, once the allies had captured the first defensive line, the Germans at both Verdun and the Somme were adept at re-capturing it by an instant counter-attack, or at least at falling back to their next position in depth, to pose a huge new logistic problem to a would-be assailant.

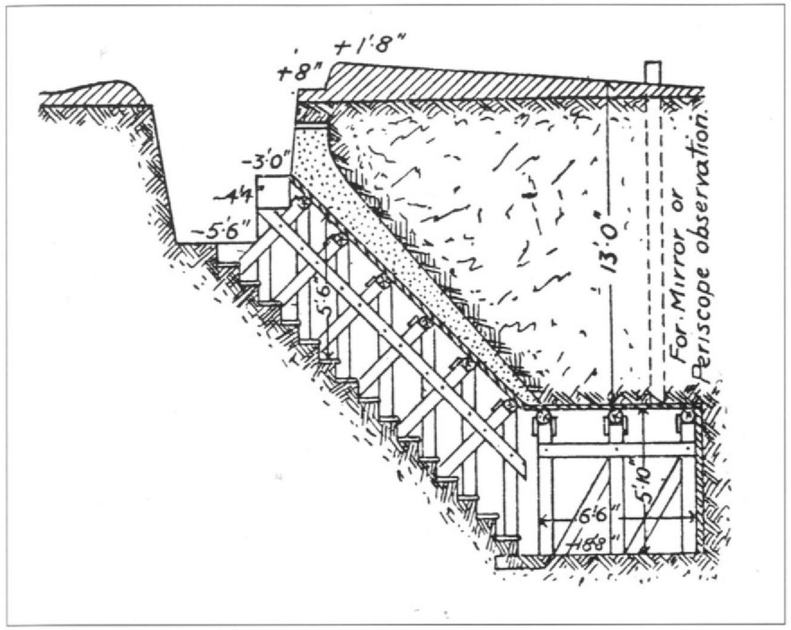
1917: the peak of German defence in depth

The problem with immediate counter-attacks was that they normally cost a high toll in casualties, even when they succeeded. Because of this, both Verdun and the Somme were fought at exceptionally high intensity, and in human



Entrance stairs from a German deep bunker captured by the 9th Scottish Division at the north end of Bernafray Wood, 3 July 1916. At this period of the war the British were often amazed and awed at German industry in digging such deep and well-funished dormitories. (Imperial War Museum, Q 4307)

terms they turned out to be as damaging to the Germans as to the allies. At the end of it all the German high command was forced to re-think its defensive tactics once again, as a result of which they adopted a wide range of significant new measures. In the first place they knew they urgently had to save manpower, so in early 1917 they shortened their line in the west by making a strategic step back of up to 30 miles from the Noyon salient, between Arras and Soissons, to the central section (out of five) of their newly built Hindenburg Line, or *Siegfried Stellung*. Among other things they abandoned the town of



German diagram of the entrance to a 19ft deep dugout. Note the great care taken to reinforce the roof of the staircase with concrete, to help prevent collapses. There was also provision for a 14in. periscope, as was recommended for most German dugouts at this time – but which was rarely seen in practice. (Museum of the Queen's Lancashire Regiment: German 1916 manual on field positions – p. 22 Fig. 14)

Bapaume, for which they had fought so hard in the previous year. In terms of defensive technique their retreat was the first occasion on which a modern army employed a systematic policy of scorched earth, including the widespread use of booby traps (as well as stay-behind machine-gun teams) to deter a rapid pursuit. This practice would become standard in the autumn of 1918, and then throughout World War II.

The unexpected German retreat delayed the allies; but the British were able to attack Vimy Ridge and Arras on 9 April, while the French launched their much-trumpeted 'Nivelle Offensive' on the *Chemin des Dames* on 16 April. Unfortunately, neither attack led to the clear breakthrough that had been promised, and Nivelle's efforts were so spectacularly unsuccessful that the French Army fell into a mutinous state throughout the summer. This shifted the main weight of the war onto British shoulders at long last, although Field Marshal Douglas Haig was doubtless ill advised to make his next assaults in the area of the Ypres salient. This was a particularly unpromising battlefield, with dreadful weather, worse drainage and overlooked from three sides by German positions. General Friedrich Sixt von Arnim had also made some serious improvements to his defences, including a layout in great depth that featured the extensive use of concrete machine-gun nests, troop shelters and command posts. The initial attack at Messines on 7 June went well enough, with the help of 19 mines using a total of a million pounds of high explosive; but the main Ypres offensive on 31 July enjoyed much less success. Despite their great superiority in artillery the British made very slow progress and managed to capture the final crestline at Passchendaele village only on 6 November.

As a final footnote to the year's operations Haig authorised a relatively small 'raid' on a weakly garrisoned section of the Hindenburg Line outside Cambrai on 20 November. This attack had originally been planned as a demonstration of the new artillery technique of predicted fire, to which tanks were later added to crush the deep wire entanglements. In the event surprise was complete and advances of five miles were achieved over previously uncratered ground. But once again there was no break-out, since the Germans were able to occupy depth positions in time, after which they re-took much of the captured ground by a major infantry counter-attack on 30 November.

The underground fighting at Fort Vaux, Verdun, 2–7 June 1916

The underground fighting at Fort Vaux, Verdun, 2–7 June 1916

Vaux was the pre-war French fort that achieved more than any other against German attack, when its variegated 600-man garrison under Major Sylvain-Eugène Raynal – many of them already wounded or sick – managed to put up a stupendous resistance that would inspire post-war planners. The defenders first disputed the main ditch with machine-gun fire from the counter-scarp galleries, and then held a succession of improvised barricades in the underground corridors leading to the centre of the fort. The Germans, commanded by Lieutenant Rackow of the 158th Paderborn Regiment, were subjected to murderous shelling while they remained outside the fort, but could make little headway inside it. Their flamethrowers were ineffective and caused many losses to the attackers themselves, although their smoke certainly added an extra dimension to the swirling cement dust, HE fumes and human decomposition odours that already pervaded the inner corridors. In the event it was only thirst that eventually forced the garrison to surrender, with a loss of no more than 100 casualties as contrasted with some 2,742 Germans.

A) German pioneers destroy steel doors with bundles of grenades, to gain access to the corridor leading from the counter-scarp galleries to the interior of the fort.

B) The underground corridors were held by a series of sandbagged barricades manned by individual grenadiers or machine gunners, who had to fight in pitch darkness. These men sold their lives dearly and succeeded in reducing German progress to a snail's pace.

C) On 4 June the Germans attempted a flamethrower attack, which temporarily silenced the defenders, but Lieutenant Girard leapt back heroically to man a machine gun in the northwest corridor in the nick of time, and although he was soon wounded, he did manage to beat off the assault.

D) The main barracks in the heart of the fort were crowded with sick, wounded and other non-combatants, and the first-aid post was always busy. On the level below the accommodation there was a lower level for stores and the (tragically under-filled) water cisterns.

E) Double gallery for machine guns covering the main ditch. These guns did great execution on the attacking troops on 2 June before they were eventually suppressed by hand grenades.

F) The main ditch.

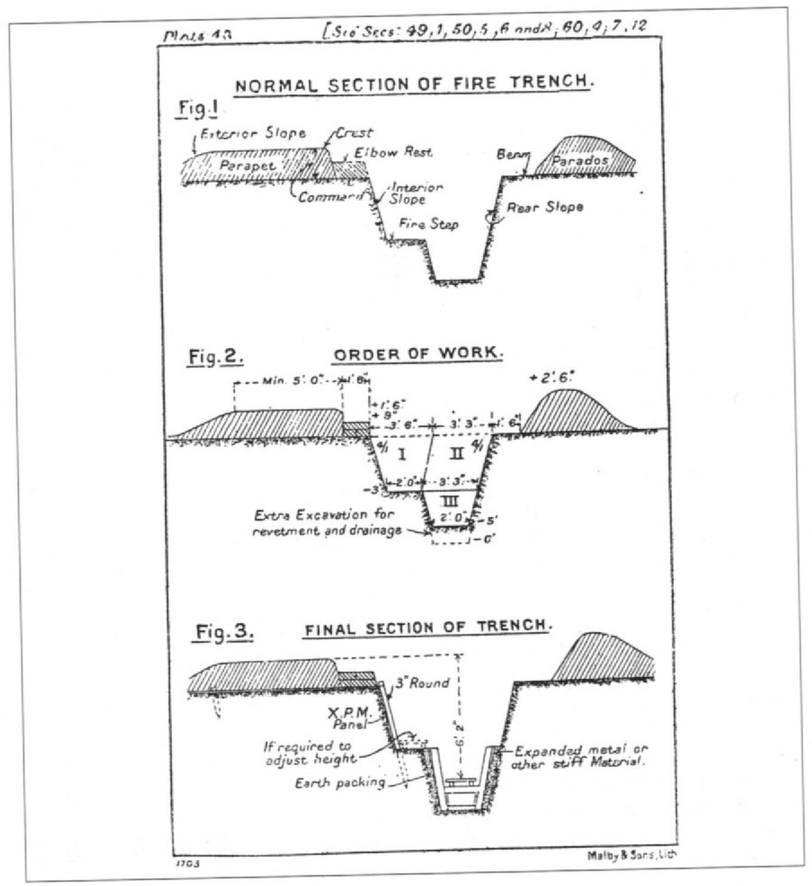
G) The 75mm gun cupola, which had been the only offensive armament of the fort before it was destroyed by a super-heavy shell early in the Verdun battle.

1918: the reappearance of semi-mobile warfare

The Cambrai counter-attack demonstrated the new German 'storm troop tactics', which were essentially the same as those described by Laffargue as early as May 1915, and then incorporated in British manuals in February 1917. These tactics were applied less completely by the Germans than by the allies, and with far fewer resources in depth; but at Cambrai and then against Gough's Fifth Army in the St Quentin offensive of 21 March 1918, they were particularly fortunate to encounter badly deployed and undermanned British defences. The actual weakness of the German assault tactics was well demonstrated by their totally futile attacks against Byng's Third Army, also on 21 March; but it is their spectacular victory against Gough that is most remembered by history. The result of this attack was to break quickly through a fragile British front line, and then disrupt the scarcely existent 'trace trenches' of the second and third lines. Although the German infantry soon outran its own artillery and logistics, the spearheads were able to infiltrate between and behind such solid fragments of resistance as they encountered, pushing westwards as much as 40 miles in 15 days. It was only then that they encountered a continuous line of resistance that they could not break, and so their commander, Ludendorff, made a series of new but ever-weakening thrusts in other directions. On 9 April a new break-in was made on the Lys, and on 27 May a third on the Aisne, followed on 9 June by a fourth towards Noyon-Montdidier, and on 15 July a fifth on either side of Reims. After that the German assault troops were left exhausted, badly dug in for defence, and lacking many of the supplies they had previously enjoyed in plenty. The initiative gradually passed to the French and the first fighting formations of Americans, who together had already held the line at Château Thierry and Belleau Wood and who had begun to mount a series of counter-attacks as early as June. On 18 July they landed a particularly telling blow near Soissons, assisted by large numbers of tanks.

Then at Amiens on 8 August the British started their own all-conquering 'Hundred Days' offensive, with French support to the south, at first against the relatively weak positions which marked the high tide of the German advance. The attack gathered momentum during the next few weeks as the enemy was successively bundled out of the Péronne Line and then all the way back to the more formal fortifications of the Hindenburg position along the St Quentin canal. At the end of September a set piece attack was launched against this line, complete with a full-scale artillery bombardment. It was entirely successful and the pace of the allied advance accelerated until the armistice on 11 November, 100 miles beyond the start line of 8 August. This represented a rate of advance that was almost as spectacular as the German march to the Marne in August 1914, and it once again seemed to suggest that fortification and the defensive were less powerful than people had imagined.

Meanwhile the French and Americans set about clearing the St Mihiel salient, south of Verdun, which was achieved against surprisingly light opposition between 12 and 16 September. Then the Americans had to make a rapid relocation for their next effort, as early as 26 September, to strike north-west of Verdun into the Meuse-Argonne region, which the Germans had carefully fortified in depth from 1916 onwards. This proved a very tough nut for the inexperienced US forces to crack, and it was only at the start of November that they were able to accelerate beyond Monfaucon and the Argonne Forest towards Sedan and the line of the Meuse. Further to the west the French were advancing across the Aisne from the area of Reims towards the Meuse around Mezières, which they also reached by the time of the armistice.



ABOVE LEFT The 'vital statistics' of a basic fire trench, including parapet, parados and arrangements for revetment and drainage channel beneath the duckboard walkway. (The 1925 British General Staff *Manual of Fieldworks* – plate 48)

Principles of defence

The principles of defence are of course as old as warfare itself, and they include such aspirations as the maximum early warning, the maximum protection and the maximum firepower.

Early warning

On the Western Front in 1915 early warning implied a well-organised system of listening posts, sentries and look-outs, using either periscopes or direct line of sight from protected loopholes. Then if they perceived a threat they would alert their comrades by firing their weapons and shouting, or perhaps also using gongs, klaxons, bells and whistles. At night there would be extra patrols in no man's land, as well as tripwires and flares. In the case of gas attack the sentries might have some canaries or white mice to monitor the breathability of the air, while against the noises made by enemy mining an alert officer with a stethoscope in a deep dug-out could be a very prudent precaution.

At more 'strategic' levels, every army corps and perhaps even every division would conduct frequent intelligence analyses of what the enemy confronting them was up to. Precisely what units were in the line, and when would they be relieved? What patterns of shelling, raiding and digging did they display? What could be discovered from air photos, sniper reports, POW interrogations or other more exotic sources of intelligence such as spies or phone-taps? On the Western Front the constant asking of all these questions often gave higher commanders good advance warning of major offensives, although it was not always so easy to convert foreknowledge into a successful defence of front-line trenches. Thus it was common for a warning to activate the movement of reinforcements towards a threatened point, only for them to arrive some hours after the enemy had launched his initial assault. They would be essential for holding the second line, but not necessarily the first.

Protection

In the case of protection, the Western Front quickly taught its inhabitants to disperse and dig in whenever possible, although they often later found to their cost that they had done neither to an adequate extent. Too many of the early photographs of this war – which may admittedly have often been taken in non-combat circumstances – show soldiers religiously following pre-war manuals by bunching dangerously close together in perilously shallow trenches. Yet it is also true that many photographs taken later in the war, when bunching was no longer an issue, still show trenches that are

Example of faulty entrenchment. (The Museum of Lancashire: Solano manual, 1914 – p. 72, Fig. 37)

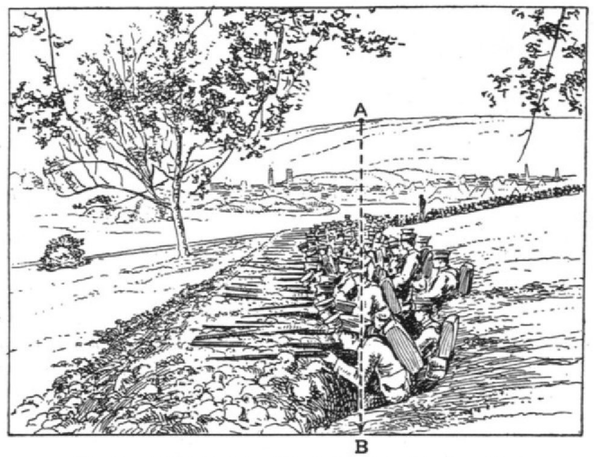


Fig. 37.—EXAMPLE OF FAULTY ENTRENCHMENT.

Obvious faults in above fire-trench are—

(i) Too many riflemen crowded in a straight line without proper "traversing," or back cover.
The enemy's artillery would seek for point *A* on the distant hill, and would sweep out the alignment *A*—*B* with shrapnel fire, taking the trench in enfilade, inflicting heavy loss and rendering it untenable.

(ii) The top, or superior slope, of the parapet is too horizontal. It will be noticed that the rifles do not lie parallel to the slope of the foreground, and cannot sweep it with a good grazing fire at night.

(iii) There is no deepened passage-way behind the riflemen for communication along the firing-line.

(iv) The surface of the parapet has not been treated so as to harmonize in appearance with the adjacent ground surface, and is not invisible from afar.

ABOVE A typical photograph of how the armies of all nations prepared themselves for what they imagined trench warfare would be like. These are men of G Company, 4/S.Lancs Regiment, in training at Loch Gelly, Dunfermline, Scotland, in September 1914. They are excessively bunched in a shallow practice trench, which appears to have no parapet, parados or traverses. Captain Avery, lurking behind a far from bullet-proof tree, is even more vulnerable than his men. Given this type of training, it should scarcely have come as any surprise that losses were excessively high in the early battles on the Western Front. (Museum of the Queen's Lancashire Regiment)

RIGHT The London Rifle Brigade bring forward hot food in back-pack containers, in a communication trench near Ploegsteert Wood about 1917. Note the signal rockets to call down artillery if the trench is attacked, and the exposed telephone cables that are virtually crying out to be cut by shrapnel. To be secure from most shell fire, they should have been buried at least 6ft below ground level. (Imperial War Museum, Q 11743)

too shallow and too little maintained with revetments or other essential features. For safety a trench should have been at least 8ft deep, and preferably with overhead cover. Dugouts with all-round protection, up to 10ft deep, were better still; while deep dormitories 30–40ft below ground level were the best of all excavated defences. By the same token it was found that even armoured telephone cables had to be dug at least 6ft below the surface to avoid breakages under any sort of concentrated artillery bombardment.

In places where the water table was high, such as at Neuve Chapelle or in many parts of the Ypres salient, it was not practicable to dig very deeply downwards into the earth without complex pumping apparatus to keep the dugouts dry. Shelters therefore had to be built upwards, above ground level, in what the Indian Army had traditionally referred to as 'sangars'. At first these were made out of sandbags, earth and stones; but by the end of 1916 both sides – especially the Germans – were building them of concrete. At first concrete was used mainly for small lookout posts or machine-gun positions fronting the enemy; but they soon came to be backed up by much bigger command posts, dressing stations, telephone exchanges and shelters, with their doors facing away

from the enemy. This surely represented a completely new generation in the history of field fortification, and before very long the use of concrete pillboxes would become universal, regardless of the level of the water table.

Concrete was often associated with existing buildings, since it was used to reinforce the entrances to cellars being used as bombproof shelters, or to protect observation posts built inside abandoned residences as camouflage. By 1917 the Germans were often exploiting the existing shape of brick buildings to camouflage the construction of whole large blockhouses inside them; for example many of the strongpoints on the Ypres battlefield were located inside moated farmhouses. These had the extra advantage that their outer brickwork would act as a burster wall for added protection. Despite the greater difficulties of camouflaging construction work in the open field, the Germans were also placing numerous concrete fortifications in exposed sites, several of which near Ravine Wood were systematically raided by the British for intelligence-gathering purposes on 20 February and 7 April. Sniper's posts made of both concrete and iron were encountered (and blown up), as well as concrete machine-gun emplacements with earth and logs covering the roof. Throughout the spring the Germans continued to build more, and bigger, concrete works throughout the Ypres and Messines area, gradually improving their technique and camouflage arrangements with sandbags, fascines or simply mud. Early unreinforced concrete designs, or works reinforced with large steel elements, such as girders or rails, were found to be fragile under heavy shelling, with excessive danger to occupants from flakes of concrete flying around under heavy concussions. Much thinner steel rods or wire meshes were found to be preferable as reinforcement, especially for the roofs of blockhouses, although the concrete for those still had to be cast as a monolithic whole, on the site itself. However, a great use was also made of large unreinforced concrete bricks,

German concrete observation post (c. 1917) at the corner of Bois Quarante, Ypres. Essentially a one-man sentry-box in the front line. (Pete Turnbull)

Block-built German pillbox (c. 1917) at Bois Quarante, Ypres. The advantage of this method of construction was that the concrete blocks forming the walls and underlying roof could be pre-fabricated at a central factory well behind the lines, and then tied together on site with reinforcing steel rods. Only the upper roof needed to be poured out on site to make a monolithic block. (Pete Turnbull)

Australians building a concrete pillbox at Wytschaete in March 1918, the high water mark of allied use of concrete before Ludendorff's spring offensive. Note the camouflage net concealing the work before a permanent earth roof can be installed. The metal reinforcement rods give a clear idea of how the work was built up. (Imperial War Museum, E 2346)

Concrete British shelter near Langhof, Ypres, built over a curved corrugated or 'elephant iron' frame, to give it a characteristically 'softer' profile than the more harshly angular German pillboxes. Because the British started to take concrete seriously far later in the war than the Germans did – in late 1917 rather than late 1916 – their concrete structures exercised a considerably less important influence on the battlefield. (Paddy Griffith)

pre-cast in a factory to the rear. When cemented together these bricks were useful as outer layers surrounding inner reinforced walls, or as burster courses on top of the roofs. In any case they later came to be cast with holes to receive steel rods, thereby allowing unreinforced concrete to be converted to a standard almost as good as reinforced. By late 1917 the British were manufacturing some similar systems of their own.

In matters of concrete the British often seemed to think on a smaller scale than the Germans, although they made efforts to catch up in the winter of 1917/18 in anticipation of Ludendorff's spring offensive. Some senior officers were even starting to say that concrete works near the surface were preferable and safer than the deep dugouts that had been the fashion in 1917. The British particularly favoured reinforced concrete shelters built over semicircular elephant iron inner linings, which gave them a distinctively curved outline, in contrast to the harshly angular lines of German MEBUs. In mid-1918, however, they moved to hexagonal designs for a new 13-mile-deep GHQ defence line covering the channel ports, which was almost a British copy of the Hindenburg Line itself. They also deployed the Moir pillbox, which was a prefabricated circular machine-gun nest with an internal diameter of just 6ft, but with an

ingeniously rotating steel shutter near the roof through which the machine gun could be fired. Unfortunately it arrived en masse only in the autumn of 1918, when the need for allied defences had largely passed. A number of other types of prefabricated steel structure were tried by both sides – including even a completely mobile German pillbox – but they were all always doomed to enclose only a relatively small space.

Apart from the trenches, pillboxes, dugouts and shelters which gave the troops personal protection from fire, the principle of protection included many other features such as barbed wire fences of increasing depth and complexity; booby traps, fougasses and obstacles such as innundations, or even areas contaminated by persistent gas. The shell craters caused by enemy bombardments could themselves quickly become almost impassable obstacles in their own right, especially when they were filled with rainwater, persistent gas or wire entanglements, so one could sometimes almost say that the more an enemy line was bombarded, the more secure it became! Shell holes could certainly be defended as ready-made firing positions, needing only a makeshift shelter in one side of the inside wall of the crater, and perhaps a communication trench to the next crater. The British manuals are full of instructions on how a group of craters can be converted into an improvised fortress, and similar practices were common in other armies. The occupation of shell holes in this way had the great advantage that they were a random feature of the battlefield which did not show up on aerial photographs as readily as a regular line, and so they tended to be less vulnerable to accurate artillery fire than a purpose-built trench. Unlike most trench systems, however, they tended to lack an underpinning network of truly shellproof dugouts into which their garrisons could retire for a safe night's sleep.

Also of great benefit could be the tactical use of the reverse slope, which had already been well known to Wellington in the Peninsular War. By 1917 the ideal was to line the crest of the hills you were defending only with light outposts, artillery observers and snipers. The main bulk of your forces would be deployed well behind the crest, where it was hidden from the enemy's artillery observers and where, if the enemy did manage to advance over the crest, it could suck him into a battle on favourable ground that was well commanded by friendly guns. Such reverse slope positions could not by any means be provided on every occasion, and even the most carefully designed defences would sometimes have to be laid out on the forward slope, as the Germans found in much of the Somme battle, at Vimy Ridge and even in parts of Third Ypres.

FIG. 8.

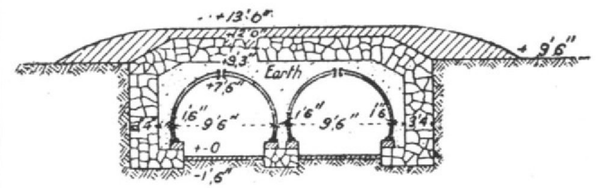
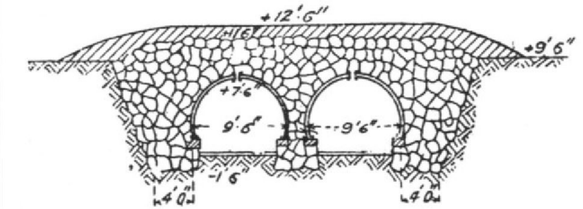


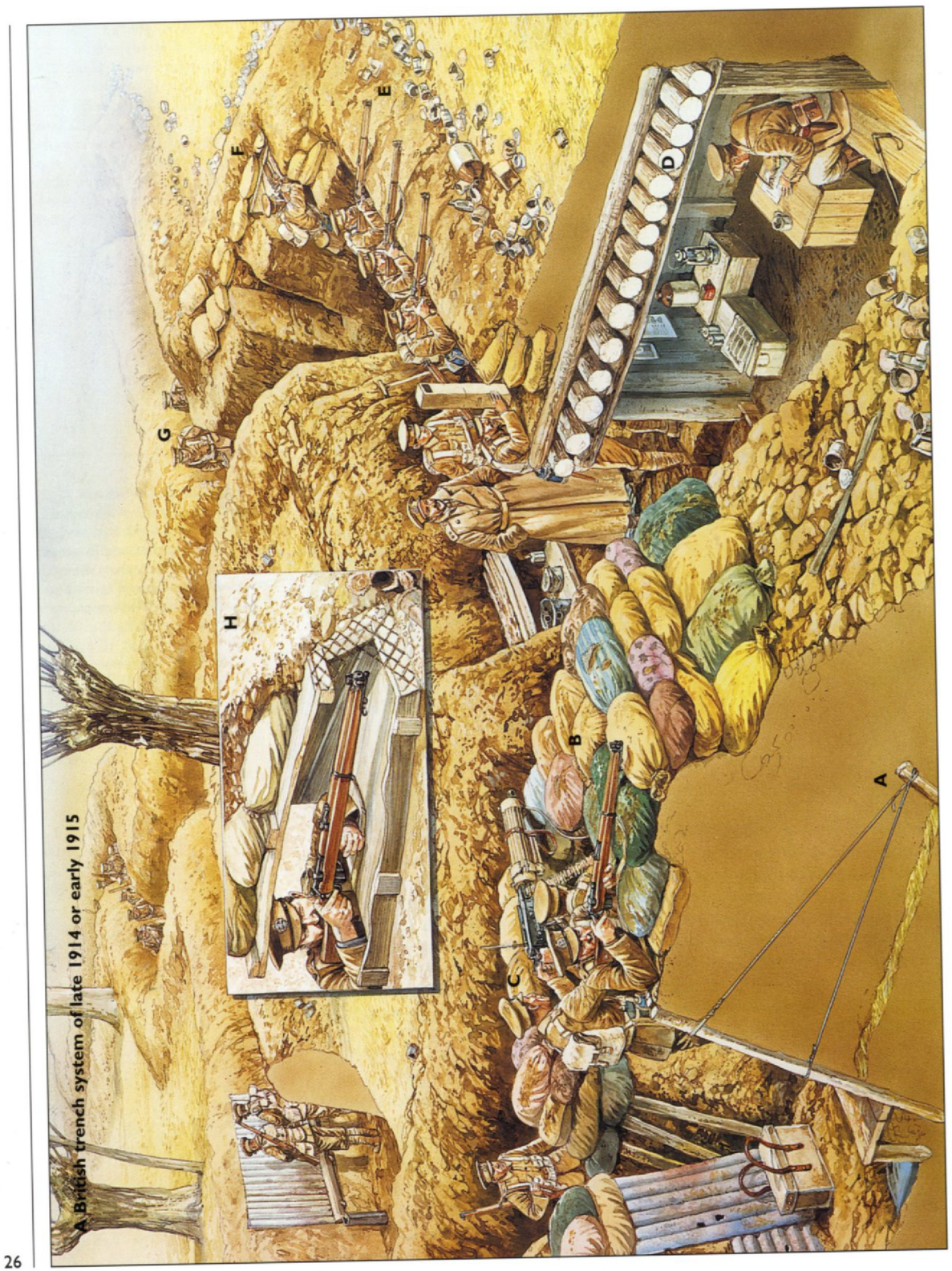
FIG. 9.



Two cross-sections of German dugout designs based on corrugated tin frames covered with layers of earth, rubble and concrete. These dugouts are not particularly deep. (Museum of the Queen's Lancashire Regiment: German 1916 manual on field positions – p. 19, Fig. 8)

Maximising firepower

When it comes to the maximisation of firepower, the siting of weapons is pre-eminent: so much so, in fact, that Solano's pre-war British manual had affected to believe that the only serious purpose of entrenchment was to allow the infantryman not only to fire his rifle, but especially to lurk in waiting before leaping forward in a bayonet charge: 'The spade is only a means to enable him (the soldier) to use his bayonet as quickly and effectively as possible.' By 1915 all armies did at least accept that on quiet days anyone using direct fire from a trench deserved some pretty complex protection in the shape of camouflage, steel



A British trench system of late 1914 or early 1915

loopholes or periscopic sights; although at moments of crisis they also demanded that riflemen should mount their firesteps and fire over the top of the parapet, exposing at least their heads to enemy retaliation and thereby at least partially abandoning the whole point of fortification.

In the case of artillery it was soon learned that it had to be pulled back to dead ground behind the front line, where it became physically blind and had to receive its firing data either from observers further forward (including in aircraft) or from barrage-planners working from the map somewhere well to the rear. The vital role of accurate mapping came to be fully appreciated by all, since without

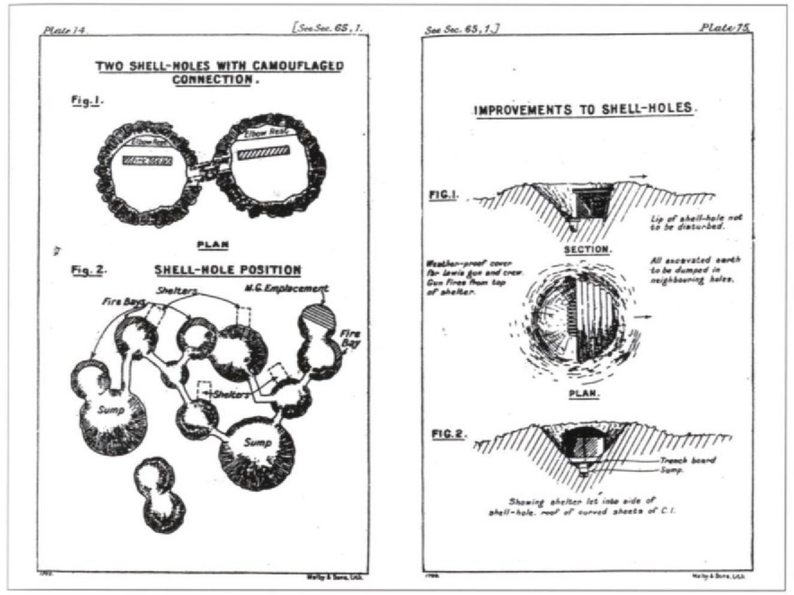


Plate 74 [See Sec. 65, 1.

TWO SHELL-HOLES WITH CAMOUFLAGED CONNECTION.

Fig. 1.

PLAN

Fig. 2. SHELL-HOLE POSITION

See Sec. 65, 1.] Plate 75.

IMPROVEMENTS TO SHELL-HOLES.

FIG. 1.

SECTION.

PLAN.

FIG. 2.

Showing shelter let into side of shell-hole, roof of curved sheets of C.I.

Diagrams showing how a group of shell holes could be transformed into a miniature fort, including arrangements for drainage and even rudimentary overhead cover. (The 1925 British General Staff *Manual of Fieldworks* – plates 74 and 75)

A British trench system of late 1914 or early 1915

It draws heavily on the advice of pre-war textbooks at a time when enemy shelling is still relatively light. The trees have not yet been blown away and the dugouts are not yet protected by many layers of overhead cover, nor are they dug very deep. The trench garrison is still far too strong for its own safety, and they are far too happy to show their heads above the parapet. In any case the trenches themselves are too shallow to offer protection to a man standing at full height – an unfortunate characteristic that would continue in most trenches of all nationalities throughout most of the rest of the war.

A) Pegging dug into the spoil raised as the trench parapet, to hold the revetments in place. A similar arrangement would also support the parados. Any trench that lacked solid revetments was liable to collapse under heavy rainfall, as would be the case on all too many occasions throughout the war.

B) The variegated colours of improvised sandbags, using furnishings or clothing pillaged from local civilian houses.

C) Vickers machine gun sited to fire obliquely along the main defensive line, rather than directly to the front. In later times it would be dug in more deeply into a fortified embrasure or even a concrete pillbox.

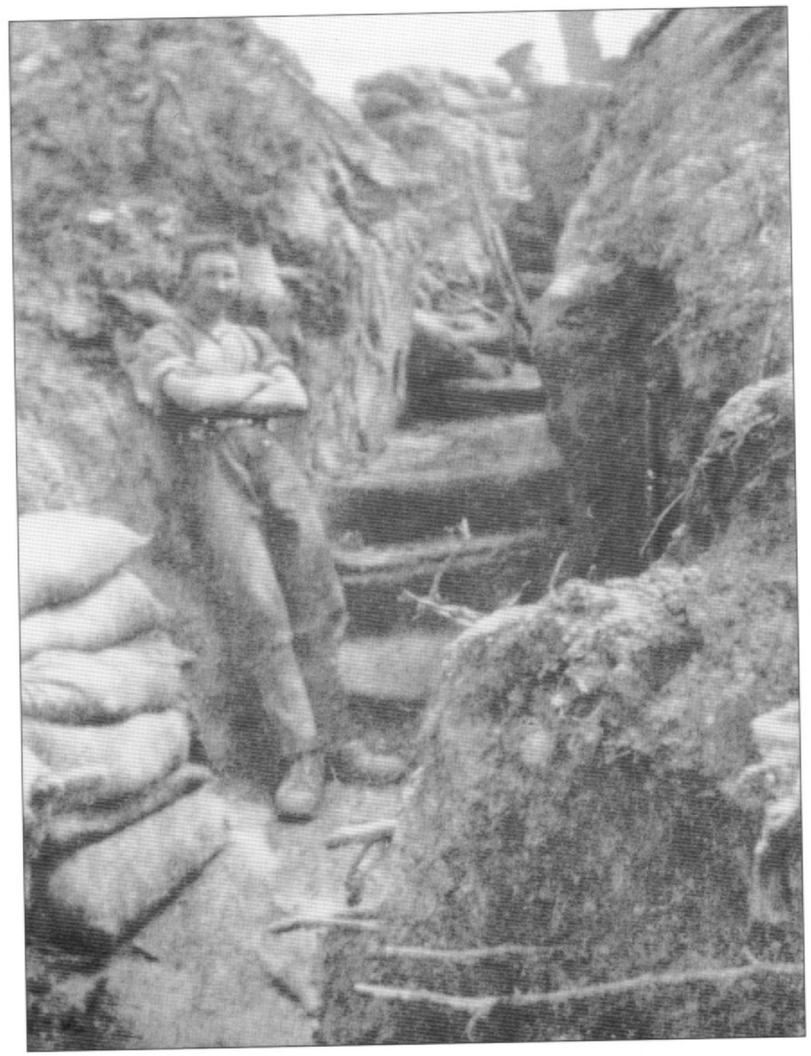
D) Logs and earth protecting the roof of a dugout against light shell fire. In later times, to resist heavier bombardments, there would be many more layers including additional materials such as corrugated iron or even concrete. Within the dugout note storm lantern, rum jar, jam tin hand grenades

E) Where else would a soldier throw his daily litter but in front of his trench? This practice helped to show the enemy exactly where the trench was sited – although normally that would be easy enough to spot in any case. On the positive side, the litter covering the frontal face of a trench could be exploited as disruptive camouflage to conceal snipers' embrasures (See H).

F) A sniper's loophole in use (See H).

G) Troops coming forward along communication trenches are forced to crouch, due to the low height of the parapet.

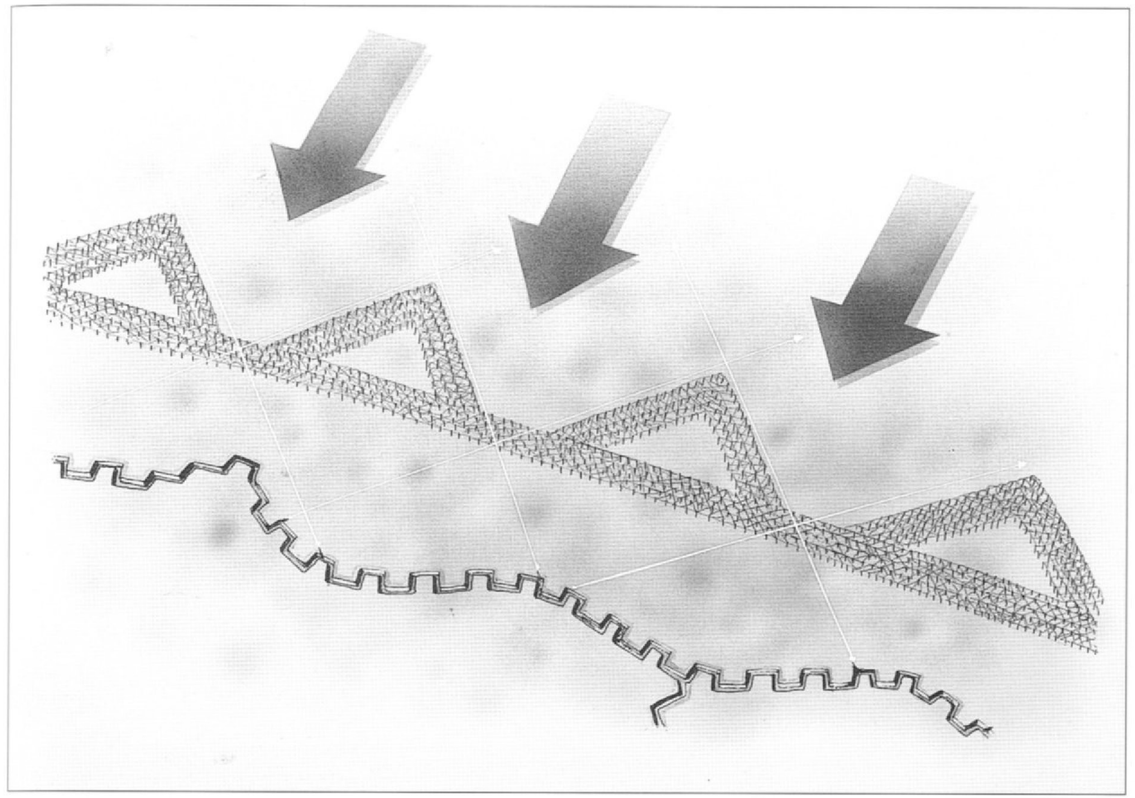
H) A sniper's timber-lined box loophole as envisaged in pre-war manuals. The frontal aperture is covered with wire mesh that can take several different types of camouflage – e.g. it can be made to blend in with the mass of litter discarded in front of the parapet.



Men of the 4/S.Lancs Regiment in trench 'S4' opposite Bois Quarante, Ypres, in 1915. Note the wide variation in trench depth, with the parapet in places being supplemented by sandbags in an attempt to minimise targets for enemy snipers. There is also apparently a lack of drainage. The protruding tree roots, however, remind us of the difficulties of digging into a wood. (Museum of the Queen's Lancashire Regiment)

it there could be no accurate artillery fire against enemy rear areas, especially when it came to CB fire. Equally the siting of forward observation posts quickly rose to a position of great importance, and perhaps the second questions asked by anyone occupying a section of trench for the first time was 'are we overlooked?' or 'where are the enemy artillery observers who can see us?' This was in many ways even more important in the long run than the very first question, which was 'can enemy snipers hit us here?'

In the case of machine guns, it was bad practice to spread them out along the line, all firing forward at 90 degrees to that line. Instead, it was essential for them to fire sideways, so that each gun position was not only protected from frontal fire by earthworks, but also from infantry attack by the fire of another gun, also firing sideways. That way criss-crossing lines of fire would leave no section of the front uncovered. Care also had to be taken to set the guns on fixed lines so they could maintain a planned network of fire in any weather or at night, or in woods. In more general terms it was always best to lay out a trench line as a wriggly snake rather than as a straight ruler, since the wriggles would maximise the opportunities for flanking fire, so that each position could be supported by another. In this way the 20th century created its own



modernised version of the classical bastioned trace that had been used in European fortress architecture since the Renaissance.

Habitability

Another vital principle of defence, albeit too often forgotten, was the habitability of fieldworks. Not only did they have to be defensible, but they needed proper latrines and drainage, unlike those reported by George Culpitt of the 10th Royal Welch Fusiliers, who said that on the Somme in late 1916:

> The trenches except in a very few places were nothing more than deep ditches, 2–3ft deep in mud and water, and although it was decidedly more dangerous to go along the top than in the trench, it was the usual way as it was not wet and uncomfortable.

Ideally – but in practice all too rarely – trenches would be decked with duckboards above the level of the dank open drain that could usually be found on the trench floor. They also needed good ease of movement and access for resupply; as well as secure sleeping quarters with overhead cover and preferably well-ventilated cookers, stoves and braziers that would not asphyxiate the inhabitants with carbon monoxide fumes. Dugouts would also be furnished with seats, tables and cupboards either pillaged from local buildings or improvised out of ammunition boxes. They would have rubber gas blankets over the doors, and increasingly elaborate pumping systems to keep the floors dry. The method of disposal for 'household waste' was normally just to throw all empty food tins over the forward parapet, which created a colourful mosaic of litter to mark the line of defence to the enemy, as well as offering opportunities for camouflaging loopholes.

The optimum siting of machine guns in a defensive line, obliquely, to provide interlocking fields of fire. This arrangement meant that any attacker would be forced to pass through at least two streams of bullets, from which casualties would inevitably be very high. If the streams of fire could also be organised to graze the forward edges of belts of barbed wire, as in the illustration, the attacker's task would be made all but impossible unless the machine guns could somehow be suppressed. (Illustration by Peter Dennis, © Copyright Osprey Publishing Ltd)

The battle of Cambrai, 20 November 1917

The Hindenburg Line had been prepared over the winter of 1916–17 as a 'state-of-the-art' fortification arranged in depth. Apart from trenches and deep dugouts it featured particularly wide and tall belts of wire, which acted as a powerful deterrent to would-be attackers. In fact it would be breached only once before the autumn of 1918, in the battle of Cambrai on 20 November 1917. Byng's British Third Army used an innovative surprise artillery bombardment with predicted fire to neutralise the defences, while a mass of tanks rolled forward to help the infantry advance by crushing the wire. Shown here is the attack at about 0930 hours (Zero plus 185 minutes) on Flesquières village, which was a strongpoint in the second line of defence, and therefore an especially difficult target to tackle on the first day of a battle. The front line has already been captured in the initial assault at dawn, and the British are now moving on to take the next ridgeline beyond it.

A) Mark IV tanks crushing the wire – a task they could do far more efficiently than shrapnel, and also a little better than HE shells even when fitted with the new 106 percussion fuse. In some cases at Cambrai the tanks also used grapnels to pull away the wire.

B) Tanks coming under field-gun fire as they approach the German defences. Note that some still carry fascines for crossing trenches, while others have already used theirs to cross the first defensive line.

C) The front trench of the German second line. Note that the British barrage had been concentrated upon it earlier, leaving the craters that can be seen, but it has now passed beyond.

D) The British barrage is falling on the German support positions on the far side of the crest line. Note the plentiful use of smoke shells as well as HE.

E) A significant element in the British attack at Cambrai was air superiority and the use of aircraft in the ground attack role.

F) a typical emplacement for a German 77mm field gun, including matting in front of the muzzle to prevent tell-tale scorching of the earth.

RIGHT Hygienic British officers in a dugout (note the stove and nice beds). (Imperial War Museum, Q 10623)

Siting defences

When we turn to the question of siting the defences, the first question to be asked was whether or not there was any choice in the matter. In many circumstances during the 'race to the sea' in 1914 the armies were pretty much forced to dig into whatever particular location they happened to find themselves. If anyone was responsible for choosing the site, it might be the high command using thick fingers on small maps, with little concern for the specific local conditions in each sector of the line. It was in this way that the front lines at both Verdun and Ypres came to be set out as huge salients around those towns, allowing the Germans to site their artillery on the outer perimeter, firing in concentrically from three sides. This would give them a great advantage in the battles that were to come, since the allied artillery inside those salients always had to fire outwards in a much less concentrated manner.

On a smaller scale the ebb and flow of the fighting in the early weeks of the war often determined which side held the high ground, the well-drained land and the sites with good road and rail communications in their immediate rear. All of these things were matters of intense importance to the fighting soldier, since they would determine many aspects of his daily comfort and security over the course of all the months and years that lay ahead. The troops were always quick to notice defects in the siting of their lines, and to criticise their commanders accordingly; but it is by no means clear that those commanders really had very much choice. It is true that when the Germans initially fell back from the Marne they chose to halt on the first major obstacle they came to, which was the long ridge of the *Chemin des Dames*. Elsewhere they always enjoyed some political latitude to keep retreating until they found a hill to occupy, whereas the allies were politically loth to abandon any inch of liberated ground. However, it is also true that because the allies' strategy was usually offensive, they would normally try to keep advancing over less easily defensible ground until they were halted in front of a significant obstacle. This meant that they were almost inevitably doomed to make their biggest attacks uphill, as they did on the Somme in 1916 and at Vimy, Arras and Third Ypres in 1917.

The organisation of the lines in depth

Once the general trace of the Western Front had been selected and the front-line trenches dug, the main question shifted to the organisation of the lines in depth. As we have seen, there was an ever-growing realisation that increased depth meant increased security, especially for the Germans. During five months on the Somme they were gradually forced back over the crest and down the reverse slope on the far side, even though their rearmost lines still held out to the end of the battle. Yet this process was highly unsatisfactory to the German planners – notably to General Fritz von Lossberg, a General Staff troubleshooter who would fly so high that he would eventually be second in the line of succession to replace Ludendorff in October 1918. The problem was that the pace of the German retreat was imposed upon them by the relentless enemy attacks, and so the new retrenchments had to be improvised at relatively short notice. By the autumn of 1916 they had therefore resolved to build their next depth positions rather more deliberately and carefully, in the form of the Hindenburg Line. This was to be a massive fall-back position backing up the whole of the front from the area of Lille to Pont à Mousson behind the St Mihiel salient. It was to be built (mainly by the slave labour of French civilians and Russian POWs) on ground so far behind the front that it could be guaranteed to be free from enemy observation or attack during the construction process. A major attack would not be launched upon it until November 1917 at Cambrai, apart from the completely botched and unsuccessful attack at Bullecourt in April by the Australians of Gough's Fifth Army on the extreme right flank of the battle of Arras.

Meanwhile other German sectors of the front, such as Champagne or the area around Arras, were receiving similar fortification that would pay dividends as early as April 1917. In particular in the early summer around Ypres General Sixt von Arnim deliberately and carefully built his own depth defences behind the existing front line. As in the Hindenburg Line itself, he envisaged a total battlefield depth of anything up to 7–15 miles, and an increasing reliance upon small dispersed strongpoints rather than upon fixed trench lines. As the noted trench raider and literary figure Ernst Jünger said of the Somme in his book *The Storm of Steel* (p. 110):

> One battalion after another was crowded up into a front line already over-manned, and in a few hours pounded to bits.
> It was a long while before the folly of contesting worthless strips of ground was recognised. It was finally given up and the principles of a mobile defence adopted. The last development of this was the elastic distribution of the defence in zones.

The new 'zones' to which Jünger referred were firstly a thinly manned 'outpost zone', in what had previously been the area of the the overcrowded front and support lines. Then came a main defence zone up to two or even three miles deep, followed after a space by a rearward defence zone of similar depth, which in turn was followed by a main artillery line and areas for the assembly of counter-attack forces. In each of the two defence zones each outpost would include smaller counter-attack elements, forerunners of the 'stormtroops' of 1918, tasked to recapture any of the neighbouring strongpoints that fell to the enemy.

A group of studious German officers in a tin-roofed dugout, who clearly do not subscribe to the view that it is un-military to read! They are members of 1st company, 27th Infantry Regiment, at Wailly in spring 1915. Being members of the Magdeburg Division, they naturally have a Magdeburg local newspaper. (Imperial War Museum, Q 51074)

As part of this new philosophy for 'elastic defence' each post was intended to be independent and self-defending. Its garrison tended to be thinned out and a good proportion of them, especially detached machine-gun teams, would be dispersed into shell holes and craters in no man's land, or in the open spaces between trench lines, for increased safety from allied artillery. They would hope to suck an attacker into the middle of a web of small but interlocking fire positions, thereby destroying the coherence of the attack and preparing the way for the 'elastic' counter-attack. This was the deliberate pattern once the Nivelle Offensive of April 1917 had become fully commited within the German line. Equally, when the British attack at Cambrai on 20 November had advanced some five miles into the Hindenburg positions, most of the ground won was successfully re-taken ten days later by a major set piece counter-attack.

The exact place of the counter-attack in German planning was always an important item on their agenda, especially since there could be no 'mobile' or 'flexible' defence without it. However, there was never any crystal-clear policy for exactly how it should be employed, and they constantly experimented with placing their main counter-attack forces (*'Eingrief* divisions') at different distances from the front line. At Arras on 9 April they were too far back to intervene immediately to throw back the initial British assault, although by the same token they escaped the effects of the bombardment, so they were still available to block any further break-out. By the middle period of Third Ypres in October the *Eingrief* reserves were at first placed too close to the front line, and were quickly crushed by the initial barrages; but when they were moved further to the rear, they still found that their forward movements could be broken up by the superior British artillery. There was apparently no real solution to this problem, and the Germans were saved only by the deteriorating weather and the shockingly poor British engineering organisation for keeping the front line supplied.

Rather more effective was the technique of evacuating the whole of the front-line defences, with the exception of a few stay-behind machine-gun teams, just before the enemy unleashed his main bombardment and attack. This was spectacularly successful on the *Chemin des Dames* against the Nivelle Offensive of 16 April, when the attacker's bombardment was wasted against mainly unoccupied positions, and his infantry had to pick a difficult path through a devastated area, to emerge beyond the reach of their own guns in the middle of a fresh, strong and active German web defence. This represented an extreme example of defence in depth and it would be used not only on several later occasions in World War I, but on still more again in World War II.

Two Canadian machine guns sited in shell holes on Vimy Ridge, April 1917. As the war went on, the best available cover above ground was increasingly to be found in shell holes rather than formal trenches. (Imperial War Museum, CO 1146)

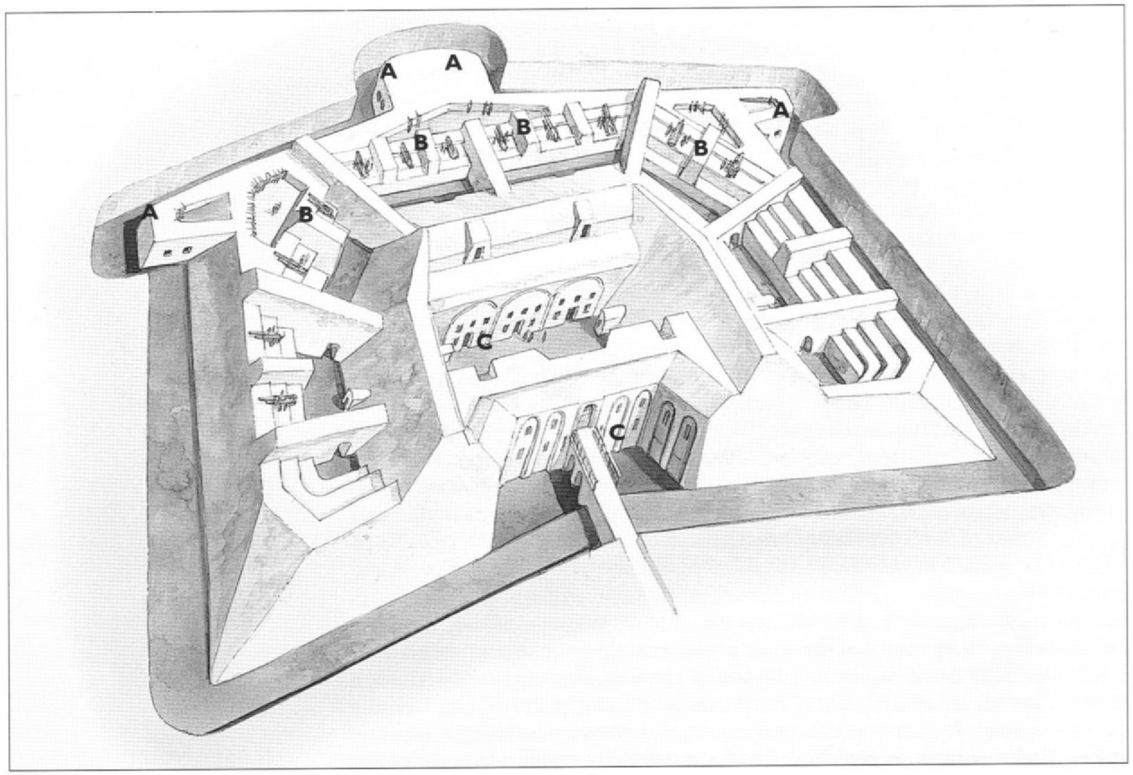
Design and developments

There were basically three distinct categories of fortification on the Western Front, each of which we will now examine in detail:
i) The permanent fortresses that were built before the war and which were often fought over during it.
ii) The hasty or improvised fieldworks that were seen during the 'semi-mobile warfare' of 1914 and 1918, but also on many occasions in the battles in between, when troops found they had to dig in hurriedly or in the spaces between formal trench lines.
iii) The evolving generations of planned (or formal) trench lines, which may be divided roughly into those built in 1915 and during the battle of the Somme, and then those of the Hindenburg Line and the mature German system of defence in depth.

i) The pre-war permanent fortresses

Despite its reputation as a battlefield fortified by trenches and other fieldworks built extempore after the war had started, the Western Front was in fact a battlefield that had been very carefully prepared with permanent fortifications for at least four decades beforehand. When General Serré de Rivières (French Director General of Engineers, 1874–80) designed his defensive system after the Franco-Prussian War, it was the most ambitious scheme of fortification that France had seen since the days of the great Vauban. It comprised some 200 different works in four distinct sectors or *rideaux défensifs* ('defensive curtains'), of which the two of greatest strategic importance were the line of mutually supporting forts along the upper Moselle between Belfort and Epinal, and that along the Meuse between Toul and Verdun. These were intended to be impenetrable 'state-of-the-art' barriers that would channel any German attack into the three 'gaps' between them, where they could then be manageably counter-attacked by the field army. The Belfort Gap was an open avenue passing westwards between Belfort and the Swiss frontier; the Charmes Gap was a similar avenue leading from Nancy through the area between Epinal and Toul,

The now deeply overgrown gorge of Fort Liouville, about 6 miles south-east of St Mihiel. This Serré de Rivières fort was selected as the archetypal target of a surprise German attack in vol.1 of the best-selling future history *La Guerre de Demain*, written in 1889 by none other than Colonel E.A. Driant – the future martyr of Verdun in 1916 (but then using the rather transparent pseudonymn of 'Danrit'). In his fiction the fort held out heroically against a frontal attack, and in the real war it also held out just behind the French front line; but it was severely pounded by artillery. (Paddy Griffith)



A typical Serré de Rivières fort, as originally built in the late 1870s in response to longer range artillery, but still in the black powder era. The bastioned trace that had dominated fortress architecture for over 300 years is now abandoned in favour of a close defence from machine guns in caponnières (A) built into the principal ditch. The main armament of the fort consists of heavy guns on open terraces (B), while the barracks and headquarters accommodation (C) are only partially protected from shell fire. Only a few short years after this the appearance of HE munitions would force fortress artillery into steel cupolas, and drive the living quarters underground or under new layers of concrete. (Illustration by Peter Dennis, © Copyright Osprey Publishing Ltd)

while the Stenay Gap passed through less open terrain between Verdun and the Ardennes forest in Belgium further north. In front of each gap, to block the German railheads, were a few independent and free-standing *forts d'arrêt* (literally 'stopping forts', but perhaps better translated as 'spoiling forts'). In 1914 the chances of war determined that neither the Belfort nor the Charmes gaps would be massively entered by the enemy, and only the advanced spoiling fort at Manonviller near Nancy would fall to the Germans' new heavy artillery. In this area the line of the Western Front would be defined essentially by the line of the Vosges mountains, which was a natural rather than a man-made obstacle. By contrast the fortified curtain between Toul and Verdun was the scene of some of the fiercest fighting of the war, not only in the struggle for Verdun itself, but also in the 1914 creation of the German salient at St Mihiel, which had been very much a part of the fortress line that Serré de Rivières had hoped to hold for France. Equally, the Stenay Gap north of Verdun had been occupied quickly during the initial German march through the Ardennes to the Marne, and would be reoccupied by the Americans only in the last few weeks of the war.

Further to the west came Serré de Rivières' remaining two fortified curtains or barriers. The first was laid out along the Belgian frontier from Montmédy through Maubeuge and Lille to the sea at Dunkirk, although the nature of the threat perceived from Belgium meant that this screen was much less dense than those directly facing the Germans on the upper Meuse and Moselle, and consisted mainly of isolated spoiling forts. Behind that was a 'second line' to defend the approaches to Paris from the north east, arranged in three groups of defences around La Fère, Laon-Soissons and Reims.[1] Unfortunately these two

[1] Additionally there were some other groups well south of the 1914–18 battle zone, at eg Langres, Dijon, Lyons and Paris itself.

lines of forts were deliberately neglected by the government during the 1890s and 1900s, and in some cases completely abandoned, so that none of them was able to survive the German onslaught in August and September 1914 apart from Dunkirk, and that was only because it was not attacked. All the rest were overrun with apparent ease, and had to be recaptured much later, often only during the 'Hundred Days' of late 1918. Perhaps the most heavily fought-over were the forts near Soissons and Laon, on the western flank of the *Chemin des Dames*, and those around Reims to its east.

The Serré de Rivières forts, like their counterparts built by Brialmont in Belgium, were innovative in so far as they finally banished the bastion from fortress architecture, adopting clean pentagonal or rectangular traces instead, in which the flanking fire would be provided from small arms within the main ditch rather than by grapeshot from the wall above. They also relied entirely on detached forts some 5–6km apart, with the spaces between them covered by artillery fire. Some of them even incorporated moving steel cupolas and shutters to protect the cannons. Nevertheless they were still built on the assumption that most gunnery would be direct fire with black powder weapons, with the result that only too soon they would become highly vulnerable to the aerial torpedo revolution of 1885, especially if the new HE shells were to be fired from mortars or howitzers to plunge vertically through the roof of the fort. This revolution gave the fortress builders of every nation an urgent incentive to use far more concrete to protect the tops of their forts, and particularly to accelerate the art of designing armoured steel gun cupolas. In 1885 the Belgian General Brialmont even went to the extent of demonstrating the virtues of a new French cupola to the King of Romania by firing at it while that particular VIP was actually inside it!

It was recognised that artillery could not hope to survive inside a fort unless it was very heavily armoured. Forts were such fixed targets and predictable shell traps that many experts started to question their utility at all, particularly since it was known that the upper limits of land-based siege guns had not yet been reached. The various ingenious designs for armoured cupolas still tended to fall short of perfection, since the more complex (sometimes even electrified!) their mechanisms became, the less reliable they tended to be in combat. For example, a disappearing Bussière turret that was installed at Verdun in 1890 was able to fire only 600 shots in 1916 until it terminally jammed. Rather more successful was the programme from 1898 onwards to upgrade and *bétonise* (i.e. 'concretise') a selected few of the Serré de Rivières forts, all in the two main sectors between Verdun and Belfort. Their masonry and earth roofs were to be covered with new layers first of some 6.5ft of reinforced concrete; then a shock-absorbing layer of at least 5ft of sand or earth, topped by an outer burster layer of especially high quality concrete. This system was very useful, if not entirely foolproof: for example, at Fort Moulainville at Verdun no less than 339 hits by 420mm guns caused major damage but still failed to cause the fort's evacuation. Indeed, this final effort marked the end of the Big Berthas' combat effectiveness.

Absolutely all movements by the garrisons were to be through underground concrete tunnels, safe from enemy interference. In the main ditches of such forts the fragile

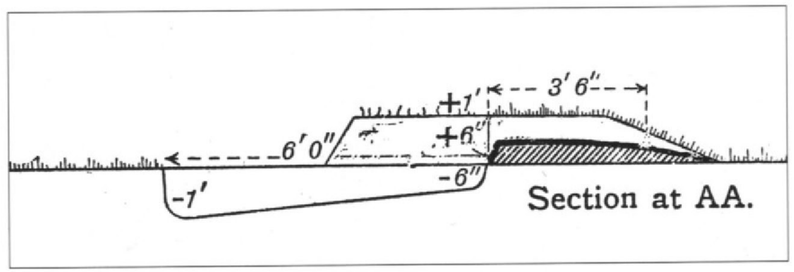
Firing ports for machine guns in the north-west counterscarp gallery in the main ditch at Fort Douaumont, Verdun. Note that the original stone walls of the late 19th century have been topped by a stronger concrete crust in the early 20th. (Paddy Griffith)

and near-vertical masonry scarp walls were to be smoothed out into gentle earth slopes that could absorb shelling with ease, at the base of which there would be little more than simple wire entanglements or iron railing grilles flanked by machine guns firing from concrete galleries set in the counter-scarp. The cost of all this, apart from the heavy financial one, was that the whole purpose of any fort now became narrowly re-defined as merely the preservation of a very few armoured artillery guns located on key topographical features, from which their fire could cover the ground betwen that fort and the next. As far as the rest of the battle was concerned, the line infantry was expected to dig trenches and other fieldworks in front of and between the forts, which effectively meant that the fixed forts were supposed to be defended by other troops. Equally the mass of the field artillery was relegated to the dead ground behind the prominent features – which ironically the experience of 1914–18 would prove to be a far better place for it than the hill crests where the forts had been located. Thus it was that a gigantic proportion of the French defence budget between 1871 and 1914 would turn out to have been wasted on fixed fortifications of very limited usefulness. All to the west of Verdun were already acknowledged to be obsolete by 1914, with the result that most of them were starved of funds, and duly overrun in the initial German offensive. On 20 October 1914 the French high command issued a directive that the absolute minimum number of garrison troops was to man the remaining fixed fortifications in the line.

On the German side many of the French fortifications that had been planned before 1870 in the newly captured provinces of Alsace and Lorraine were duly completed; but a series of new ones was added around Thionville, Metz and Strasbourg. The most modern of these were known as '*festen*', each of which was less a ditched fort than a wired defensive zone covering some 100–200 hectares (40–80 acres), to include three or four dispersed concrete batteries as well as supporting casemates, turrets and underground barracks all connected by communication tunnels. These '*feste*' positions were very influential and represented the next clear generation in the art of fortification after Serré de Rivières and Brialmont. Before 1914 they were already being copied by the French at Roppe, near Belfort, and at La Grande Couronné outside Nancy; while following the war many of the same principles would be revived in the Maginot Line. The *festen* were not, however, put to any serious test in the Great War, although the 'Kronprinz' *feste* outside Metz (renamed by the French as 'Driant') turned out to be so strong that it held off Patton's Third American Army for a month in 1944, and was never actually overrun.

ii) Hasty or improvised fieldworks

During phases of 'semi-mobile warfare', as in the first three months of the war, and then again in both the spring and autumn of 1918, troops would often find themselves coming into action in places where no fieldworks had previously been built. They would have to create some sort of protection for themselves as fast as possible, and by any means available. Equally, troops who were forced to go to ground during an attack in any of the four years of war would also have to look around to find cover, although of course if their battlefield had been heavily bombarded, they would probably enjoy a plentiful supply of welcoming shell craters.



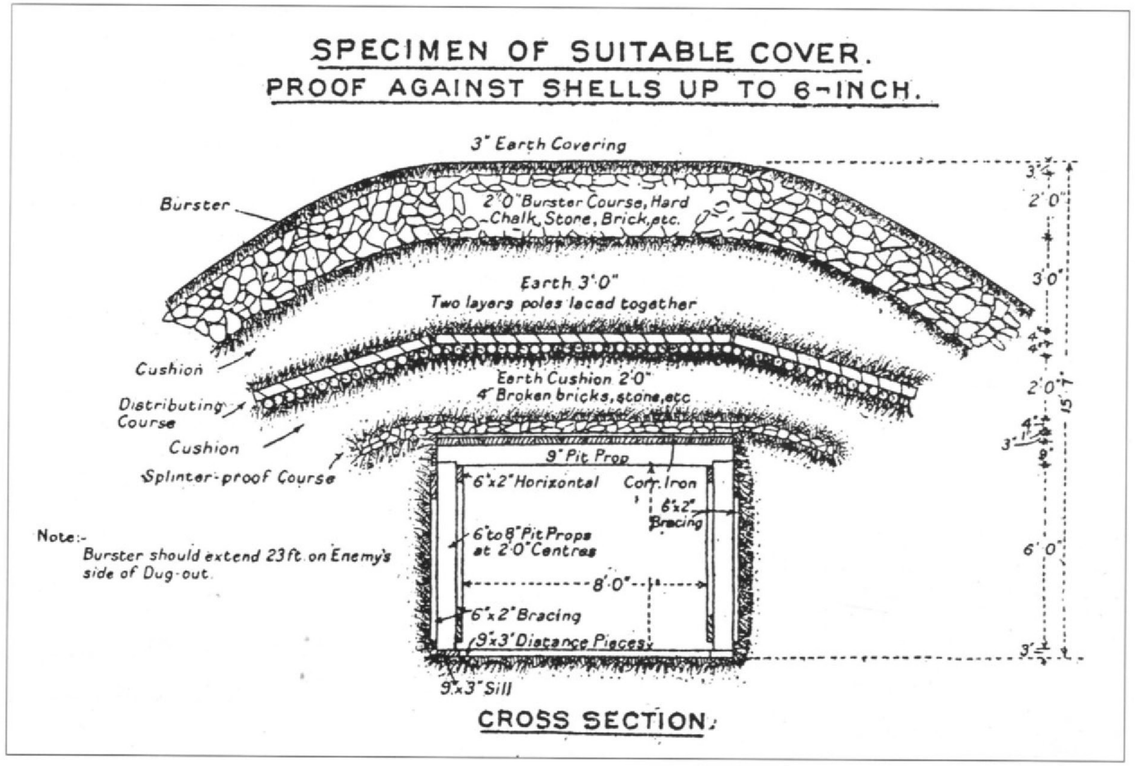
Cross-section of a fire trench to be scraped out in a few minutes, using the 'grubber'. The prone rifleman has 1ft of cover from the front, or 1ft 6in. from the flanks. If threatened by shrapnel shelling, the recommendation is to dig a deeper hole to sit in, rather than lying prone. (The Museum of Lancashire: Solano manual, 1914 – p. 60, Fig. 16)

In completely virgin farmland there was usually some sort of cover behind which individuals, or even whole platoons, could find protection from direct fire from the front. As the 1925 *Manual of Fieldworks* explained (p. 8):

> This cover may consist of hedges, walls, buildings, banks, sunken roads, railway embankments and cuttings, woods and shell-holes. All of these are easily convertible into strong defences if intelligently treated … troops well trained in adapting natural cover to defence are extremely difficult to eject when once they have dug themselves in.

We can add that in order to avoid fire from the flank or rear, and especially to escape indirect fire, it would be necessary to find some sort of shelter below ground level, such as a drainage ditch, although even then it was likely to be dug in straight lines, without traverses or other wrinkles, and so potentially vulnerable to enfilades or direct hits by shells.

Whatever the specific tactical situation, the immediate need would always be to scrape out additional protection using entrenching tools, bayonets, steel helmets or even bare hands. Normally in the BEF each man would carry a small shovel or a 'grubber' (a customised hybrid of pick and shovel), whereas the picks and other tools would normally be issued centrally by the engineers. The engineer tools were regularly thrown away by the infantry as too heavy to bother with, so that salvage squads had to be formed to recover them. Later in the war a third of the infantry would be issued with picks instead of shovels, so they would become more accountable for them. Whatever tools were used, digging-in under fire in daylight could be a peculiarly uncomfortable and



An ideal scientific method of protecting a 15ft. 7in. deep dugout against 6in. shells. This system uses alternating layers of earth, rubble and timber, but reinforced concrete would have allowed the roof to be less thick. (The 1925 British General Staff *Manual of Fieldworks* – plate 147)

lonely task, since it would have to be done from the prone position and often, in an 'empty battlefield', under fire and without knowledge of what one's comrades were doing. It would all become far easier after nightfall, when men could stand up not only to dig, but also to communicate with each other. Perhaps the most difficult thing of all in these circumstances was for officers to go round and impose a coherent line upon the multitude of individual scrapes that had been started without any plan. Many of them might be found to have been poorly sited, so a great deal of earlier effort might heartbreakingly have to be filled in and repeated in other positions. Ideally, any trench line was supposed to be surveyed and fully planned by an engineer officer before any digging began; but in the rough and tumble of 'semi-mobile warfare' this was far from always possible.

The rate at which work was expected in 'normal' soil was for each man to dig out 20ft³ in the first hour, or 60ft³ in the first four hours. For the individual, according to Solano's 1914 manual, that could represent a personal hole some 4ft deep with an additional foot of parapet above ground. However, for any more ambitious work it would provide far less protection. Given that a trench was supposed to be about 6ft 9in. wide, and each man might dig a 4ft section of it, that means he would dig down only about 9in. in the first hour, and little more than 2ft by the end of the fourth hour. Only by then would he start to enjoy even a minimum of real security from bullets and flying shell fragments, and it would take many more hours of digging before he could breathe easily. Thus it might well be the end of the second night before a real 'trench' worthy of the name could be said to exist, and even then it would still be likely to collapse in heavy rain unless careful revetment was taken in hand. It would also lack many of the essential amenities required for proper long-term habitation – such as drainage, duckboards, wire obstacles, communication trenches to the rear and dugouts for secure sleeping accommodation. In practice many of the trenches that were started would never ever be completed to a full standard, especially on the allied side where defensive measures were too often seen as only temporary. In these circumstances the British would routinely complain about the slack standards of their continental allies, particularly in the matter of sanitation. It seems that even after a long occupation, allied trenches were frequently left very little better developed than they had been at the end of the second night's digging. It is debatable, however, whether the British were always much more virtuous than their allies. As the commander of 10th Canadian Engineer Field Company put it in December 1916, 'In certain areas of the Somme, the men holding the line, preferred to sit in mud and water over knee deep, than exert themselves to clean the trenches.' The infantry would wait for the engineers to come and improve their trenches, while the engineers would grow weary of explaining to the infantry that this was exclusively an infantry responsibility.

French troops posing self-consciously in their new horizon blue uniforms, in an elaborate (and surely not combat-proven) trench, 1915. At least the trench is well made with a firestep, drainage ditch, and even hot food containers. Alas the officer lurking with the binoculars in the old navy blue uniform looks particularly vulnerable to enemy fire. (Dr Stephen Bull and the Museum of Lancashire)

The whole depressing business of digging minimal trenches, and living in what were essentially little more than mud holes, was surely enough to dissuade any modern man from digging any deeper or investing any great energy in furnishing himself with an elaborate dugout, especially if he knew he would be relieved within a couple of days, and would therefore be working for the comfort of some complete stranger. As Harry Siepmann would say (pp. 73–76), in the first year of war no one wanted to dig in – although he did quickly add that by the second year they wanted to dig in even more than was needed. Harry could perhaps see the latter process more clearly than most since he served in the artillery, where they tended to stay in the same positions for weeks rather than days on end, receiving relatively little incoming fire. They enjoyed both the scientific knowledge to imagine fantastically elaborate multi-layered dugouts, and sufficient leisure time to actually build them. Thus by 1917 Harry himself would boast of his great skill in constructing top class dugouts with complex corrugated iron, timber, earth and stone roofs, using materials that he had systematically robbed from his comrades.

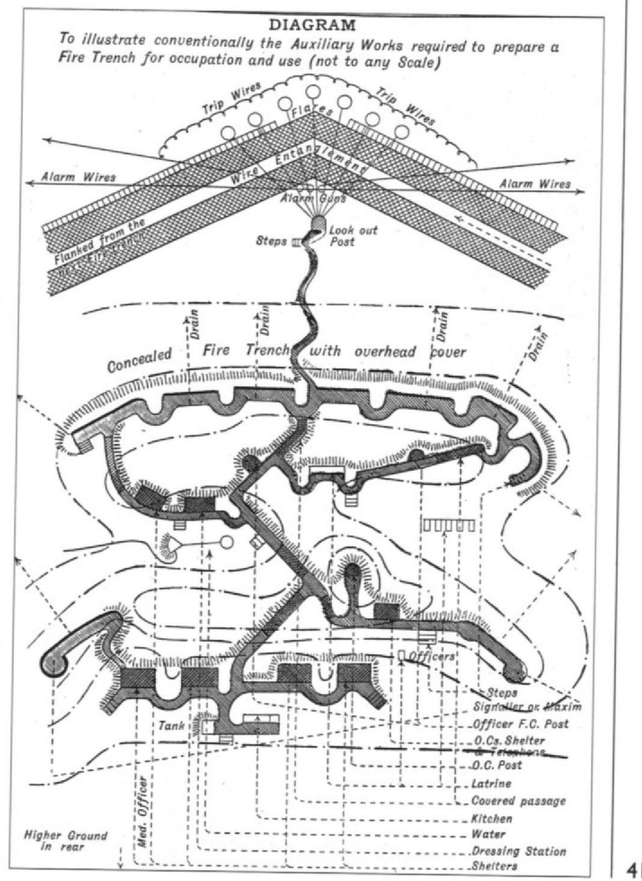
iii) The evolving generations of planned trench lines

a) 1914–16

Once the armies had been settled in the Western Front for a good time, and had realised they were there for the long haul, they began to take their trenches more seriously than they had at first. By the spring of 1916 they had evolved advanced methods for both the construction and the manning of their trench lines, which allowed the deadly business of positional warfare to be conducted as a routine, and almost a 'normal' way of life. Indeed, in many 'quiet' sectors there was so little activity from one week to the next that it scarcely amounted to warfare at all, except in a highly ritualised way in which both sides had a tacit understanding that they would minimise the casualties they inflicted on each other. For example, the artillery might fire only at certain set times each day and always at the same targets, allowing the enemy to take cover every time. This 'live and let live system' has been excellently described by Tony Ashworth who found, for example, certain British battalions that spent a whole year in the trenches but suffered only one officer casualty. This is the opposite side of the coin to the ferocious bloodbaths seen in the major offensives, for which World War I is notorious.

The four distinct elements in a classic mid-war defensive position were:

i) The front line, which consisted of the first fire trench and the second or 'support' trench some 70 to 200 yards behind it. There might even be a third trench yet another 70 to 200 yards in rear. Each of these two or three fire trenches might be doubled up by a command and communication trench for general administrative purposes just a few yards behind it. Hence 'the front line' might actually consist of as many as six parallel lines of trenches all packed into an area that was perhaps little more than 300–600 yards deep. More normally, however, there might be nearer two than six actual trenches.



The auxiliary works needed for long-term occupation of a fire trench. Note particularly the complex arrangements for alarms and trip wires in the forward wire entanglements, as well as its siting to allow flanking fire. Drainage, sanitation, water supply, cookery and medical aid are all envisaged in this concept of a well-built front-line trench. (The Museum of Lancashire: Solano manual, 1914 – p. 211, Fig. 87)

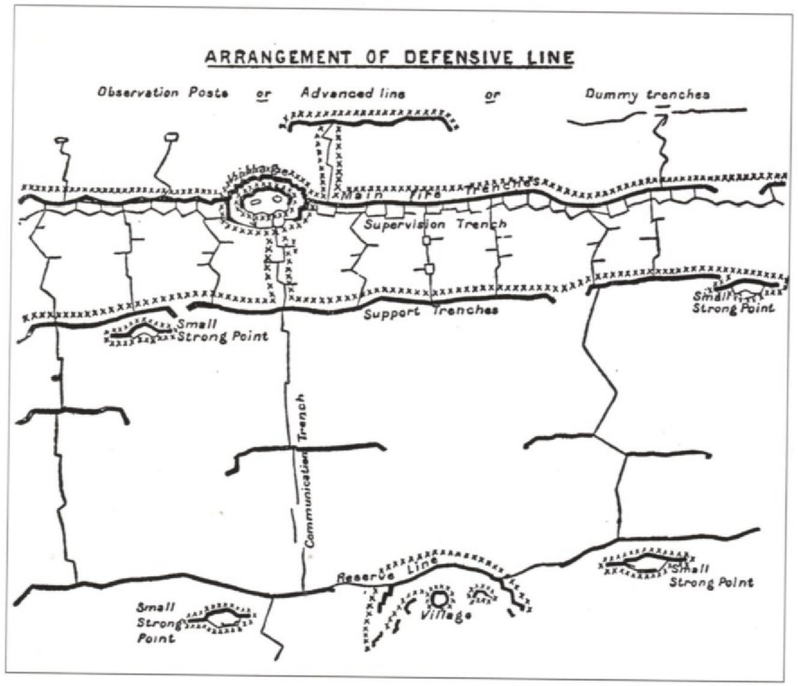
Aviator's view of a textbook British trench system on the Somme, May–June 1916
The aircraft is an Albatross CI observation plane. The picture (from left to right) shows a double belt of wire covering the two lines of trenches that form 'the front line', behind which there are communication trenches protected by wire and redoubts facing outwards. Behind these again is another belt of wire and then the two trench lines of the 'second' (or 'support') line of defences.
A) 'Russian sap' – a buried trench allowing troops to emerge in the heart of no man's land.
B) Deep belt of wire. Note that narrow passages through the wire would be built into the system, to allow parties of troops to access no man's land for raids or major attacks.
C) Listening post or machine-gun position set slightly ahead of the main trenches.
D) Site of a dugout just behind the main trenches.
E) Redoubt dug into communication trench for flank defence in case of an enemy break-in
F) Underground medical aid post
G) Telephone cable head. A tactical command post cannot be far away!

ii) The 'reserve line', which might be 500 or 600 yards behind all of the above (preferably under the cover of contours).
iii) The logistic rear areas and the gun line for the field artillery, maybe as much as a mile further back again.
iv) The communication trenches or access routes linking all these together from front to rear.

By 1916 in many places, especially on the German side, all this came to be considered together as merely the 'first line of defence', with an identical 'second (or rearward) line of defence' being built some two to four miles further to the rear for extra security and depth.

Ideally a man should have been able to enjoy the protection of some sort of communication trench for his whole journey to the front line – and occasionally even halfway across no man's land as well – wherever he was within range of enemy shelling. In practice the long range of modern artillery often allowed it to reach back well behind the rearward ends of the communication trenches, into a zone where men who might sleep in dugouts would normally have to run a risk of random shelling as they went about their normal business on open ground. This was particularly difficult for those riding in wagons, motor vehicles or light railways, which were doomed to follow predictable roads or tracks that could not be hidden from aerial observation. These could even take on strategic importance, as in the case of the *voie sacrée* ('sacred road') at Verdun, which was the only road by which the defenders of the salient could be resupplied. It took a very special effort of traffic management and policing to keep the motor lorries moving regularly along it in both directions, day and night, including rapid repairs to restore the road surface whenever a shell hit it.

Communication trenches were built differently from the 'parallels', or the lines of trenches that faced the enemy. They had to be wide enough to take a continuous stream of one-way traffic (sometimes including even mules or light railways), which would be routed either 'up' to or 'down' from the front. In rearward areas there might be one 'up' and one 'down' trench per battalion in



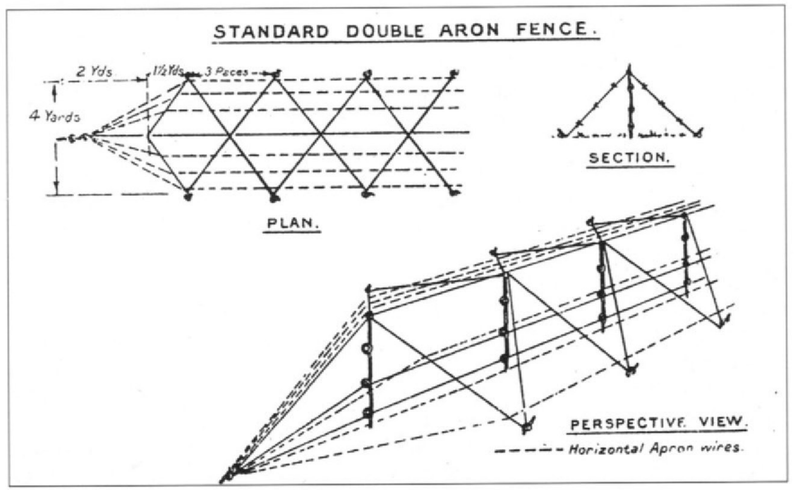
Arrangement of a defensive line. Note the strongpoints or 'keeps' (with all-round defences) incorporated in every line, as well as the 'sidings' off the communication trenches for sheltering reinforcements. Also note the 'supervision trench' immediately behind the front-line fire trench. (Museum of the Queen's Lancashire Regiment: *Notes for Infantry Officers on Trench Warfare*, March 1916 – Fig. 1)

the line, but nearer the front there would be more, and eventually even as many as one communication trench per 50 yards, or behind every second traverse. Communication trenches would have occasional recesses to allow overtaking or the passage of stretchers, and they would also often carry telephone cables to link the rear with the front. Sharp-angled traverses were to be avoided, instead of which a trace of shallow zigzags, at 15- or preferably 10-yard intervals, was preferred; but ideally with at least one long straight section covered by fire from a loopholed bunker, to prevent bombing in case of infiltration. For the same reason there should also be trench blocks or knife rests at intervals, to allow any attacker to be contained. Equally, there was a requirement to provide communication trenches with occasional redoubts (which might be shaped like a 'T' or 'D') or at least firesteps, so that fire could be delivered to the flank and thus the whole trench could be converted into a 'switch line' at 90 degrees to the original front-line trenches.

The end point of a communication trench consisted of the two (or three) front-line trenches, which in 1916 functioned together not only as the foremost 'outpost line' but also as the main line of resistance. Often they would be sited perilously close to each other, with a risk that they might all be broken together by an enemy attack. In that case the next line of defence in the rear areas would have to be rather hastily improvised on the basis of the original reserve line, by which time it was certainly to be hoped that the high command would have sent some reinforcements to help plug the gap.

The front fire trench was often quite close to the enemy front line – sometimes even within range of grenade throwing, although more normally there would be at least several hundreds of yards between the two sides. The front trenches would be particularly heavily wired, and in theory actively patrolled by night, according to the doctrine of 'dominating no man's land'. This concept was usually unpopular among the troops who were called upon to leave their safe dugouts to risk their lives in the open; but it was particularly prevalent in some of the more aggressive BEF divisions, and its alleged advantages were many. If your patrols were active every night all the way up to the enemy's wire, it prevented him improving his own defences or interfering with yours; it gave you a chance to take prisoners for intelligence purposes; and it enabled you to prepare no man's land as a jumping off place for major attacks, allowing assault troops to lie out overnight before zero hour very close to the enemy.

As for the wire itself, it would ideally start some 20 yards in front of the front fire trench, with preferably another line at 40–50 yards, to keep enemy bombers out of range. Entanglements might be based upon a low vertical four-



Standard double apron fence. This was the 'basic building block' of British wire entanglements, which might consist of one fence on its own or several parallel fences with additional coils of wire arranged between them. They might also be scattered with beds of sharp broken glass or a variety of tripwires to alert defenders of any intrusion. (The 1925 British General Staff *Manual of Fieldworks* – plate 32)

British wire at Mametz, 28 August 1916. Note that it is laid out as two textbook double apron fences: compare it with the theoretical diagram in the manual as seen on the previous page. (Imperial War Museum, Q 4181)

strand fence similar to those commonly seen in agriculture today, using timber posts or screw pickets 2ft 8in. or 3ft 6in. high. With a double apron there would be inclined strands crisscrossing from the top of the fence to meet the ground 6ft in front, and others meeting the ground 9ft in rear, among which might be strung additional entanglements. A stronger arrangement was to supplement this original fence with a second one some 6ft to the rear, with the gap between the two being filled with loose wire or concertina wire. There were many possible variants and alternatives, such as entanglements set at calf height, just 9in. above the ground, or the massive 9ft-high mounds of concertina wire many yards deep seen in the Hindenburg Line. There were rapidly laid entanglements, mobile entanglements (or 'knife rests'), concealed entanglements located in ditches, and plenty of other fiendish arrangements besides.

In essence, each of the two (or three) front lines would consist of a continuous trench with frequent traverses, with perhaps a second 'command trench' immediately behind it. In some places there might be a free-standing 'keep' or redoubt organised for all-round defence – perhaps in the site of a village or other focal point in the terrain. In 1916 such works would be seen as somewhat incidental to an essentially linear defensive trace, although by the following year they were starting to be appreciated more as independent strongpoints, which needed very few defences in between them. The trenches themselves, in other words, were being seen less and less as linear fire positions than as mere pathways between strongpoints.

The whole front-line complex would be dotted with firesteps, machine-gun posts, sniper posts, observation and/or listening posts, sally ports and a variety

German trenches and deep dugouts

Well-prepared German trenches and deep dugouts in advance of the Somme battle, spring 1916, before the progress of the allied attack forced the hasty construction of new, less carefully built, defences further to the rear. The strength and quality of the German earthworks discovered in the front two lines on the Somme shocked the British assault troops, who had seen nothing like them on their own side. In particular the shelters and dormitories (*Stollen* or *Hangstellung*), buried some 20ft below ground level, offered enviably complete security to their garrisons. They boasted many advanced features such as multiple exits, anti-gas curtains, drainage sumps and pumps, full cooking facilities and sometimes electricity generators for lighting. This accommodation allowed large bodies of troops to be held ready to make instant counter-attacks if the enemy gained a lodgment, while the trenches above ground could be left with relatively light garrisons in normal times.

A) A 'knife rest' of timber and barbed wire that could be pulled down to make a trench block if the enemy managed to penetrate the system.

B) Wicker revetments: a favoured system for holding in trench walls when solid timber was in short supply.

C) Machine-gun embrasure. On many occasions the Germans' static defence relied almost exclusively on machine guns supported by mobile counter-attack forces.

D) Boxed sniper embrasure. If no sandbagged loophole of this type could be built into the parapet, the Germans often used steel shields as personal armour for trench defenders.

E) In the best-made or 'ideal' trenches the walkway would have a central drain covered by duckboards, while the firestep and revetments would be carefully built with timber. None of these admirable features, however, was commonplace in most sections of the line.

F) Flexible gas curtain made of canvas with wooden slats.

G) The classic tunnelling system, derived from civilian mining, used timber flooring, walls and ceilings. For a more modern alternative, see L.

H) Drainage sump.

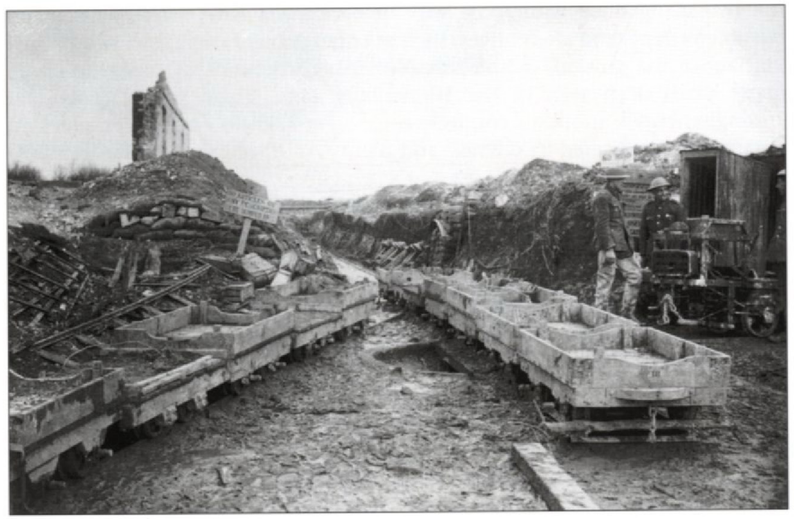
I) The cramped dormitory spaces, with bunks two or even three tiers high, could accommodate surprisingly large numbers of men in relative luxury!

J) Gas alarm made from a used shell case.

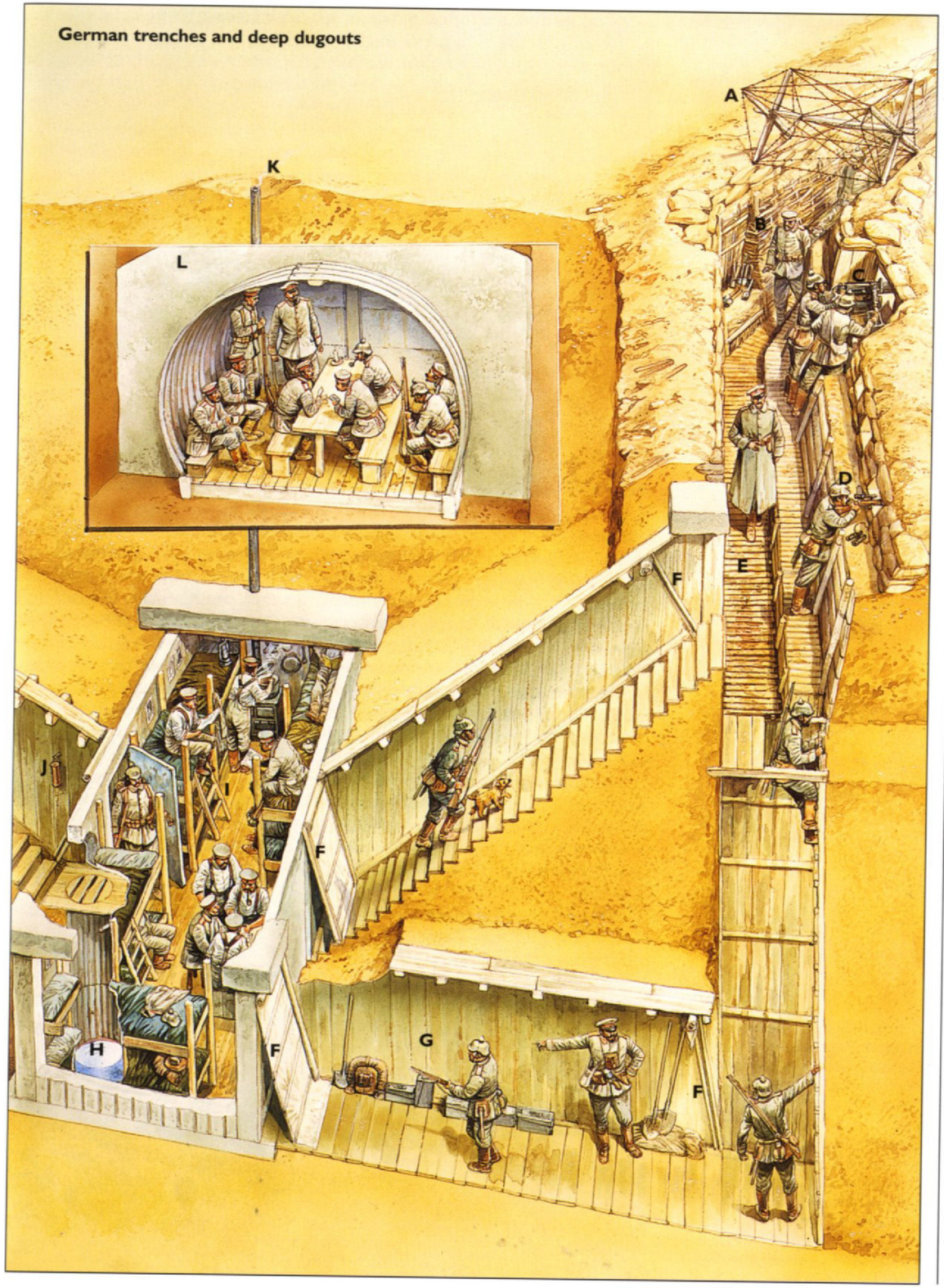
K) One of several air vents – an essential facility for life underground!

L) A modern shell-proof tunnelling system, based on corrugated iron encased in concrete, that could be dug closer to the surface than the traditional earth and timber type.

of dugouts or recesses for command posts, telephone exchanges, medical aid posts or dormitories (including especially deep ones on the German side). Often the machine-gun, sniper and observation posts would be thrown a short way forward of the line, connected to it by a sap, and even as early as 1916 some of them might be made of concrete. Latrines, drainage sumps, ammunition stores and trench mortar pits would be dug a short way to the rear. To assist forward movement above ground – for example to help reserves come forward in an offensive, including artillery, cavalry or tanks once early success had been won – there might sometimes be a series of bridges across the trench lines. Also to help an offensive, extra assembly trenches and 'sidings' out to the flanks of communication trenches might be built to allow large numbers of



Narrow gauge railway in a trench at 'Oxford Circus', outside Arras, April 1917. Trench logistics were very greatly enhanced by this type of transport, although the majority of the 'decauville' tracks were laid to the rear of the communication trenches, often coming no further forward than the artillery lines. Some, however, extended much further forward, and even as far as the front line itself. (Imperial War Museum, Q 5093)

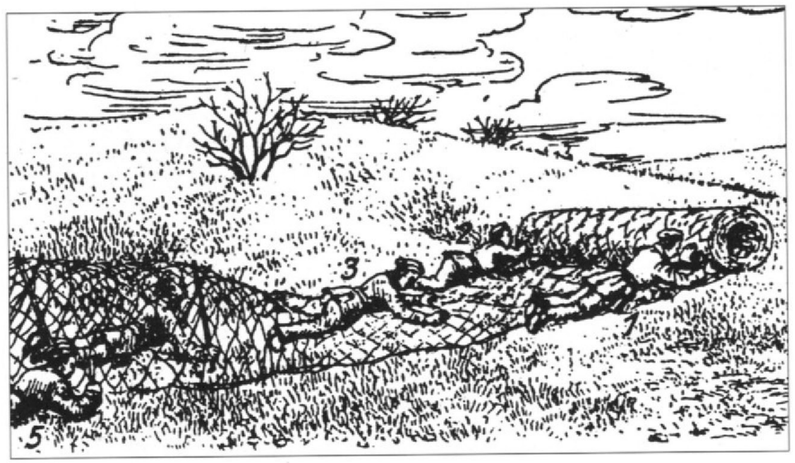


troops to 'go over the top' together. In the German case, as we have seen, the role of these assembly trenches might be fulfilled by underground *stollen*. Yet because it was naturally hoped that the attack they were built for would be successful, such jumping-off positions were intended to be used only once, and so they would not be built to a high standard.

Arrangements for command and control varied from one army to another. In the British Army a particular set of trenches would be occupied by a particular army corps, consisting of several divisions, whose commanders would command their parts of the sector until such time as they were relieved. Each division would have a central axis for its own logistics and telephone cables, as well as a separate telephone net to connect artillery observers at the front with the guns well behind (by 1917, however, it was becoming widely known that phone tapping was a distinct danger anywhere within 6,000 yards of the enemy line, which often included the friendly gun positions). Within the division the three brigades would be successively rotated through the front line (one or two 'up'), and within each brigade each battalion was rotated so that it would occupy the most dangerous posts for only a few days at a time. In this way men might spend perhaps ten days in or near the front line; ten days around the reserve line; and ten more supposedly 'resting' behind that: although it was notorious that such rest periods were taken up largely in fetching, carrying, cleaning and especially digging.

At all levels, therefore, the British command structure for defence rotated fairly regularly, right up to the level of the corps. In this respect the German arrangement included a slightly more permanent element, especially at corps and divisional level, where permanent commanders and HQs would be appointed to organise the artillery, signals and logistics framework in particular sectors for the duration of a given battle, so they could remain in place and oversee the general shape of the battle as successive infantry divisions, regiments and battalions were rotated in and out. This ensured greater continuity in tactics, as, for example, in the central German section of the Somme defences, where Sixt von Arnim and von Lossberg supervised the gradual imposition of successive lines in depth until November, then proceeded to Ypres, where they were able to apply the lessons learned to the battlefield there.

Regardless of the army concerned, there was rarely any suggestion of 'chatêau generalship' at the levels of divisional or brigade commanders, who would all usually live in dugouts in the reserve line or level with the gun line, although they would admittedly be a significant distance behind the battalion commanders living in the support line. It was only at the level of a corps or army HQ that more



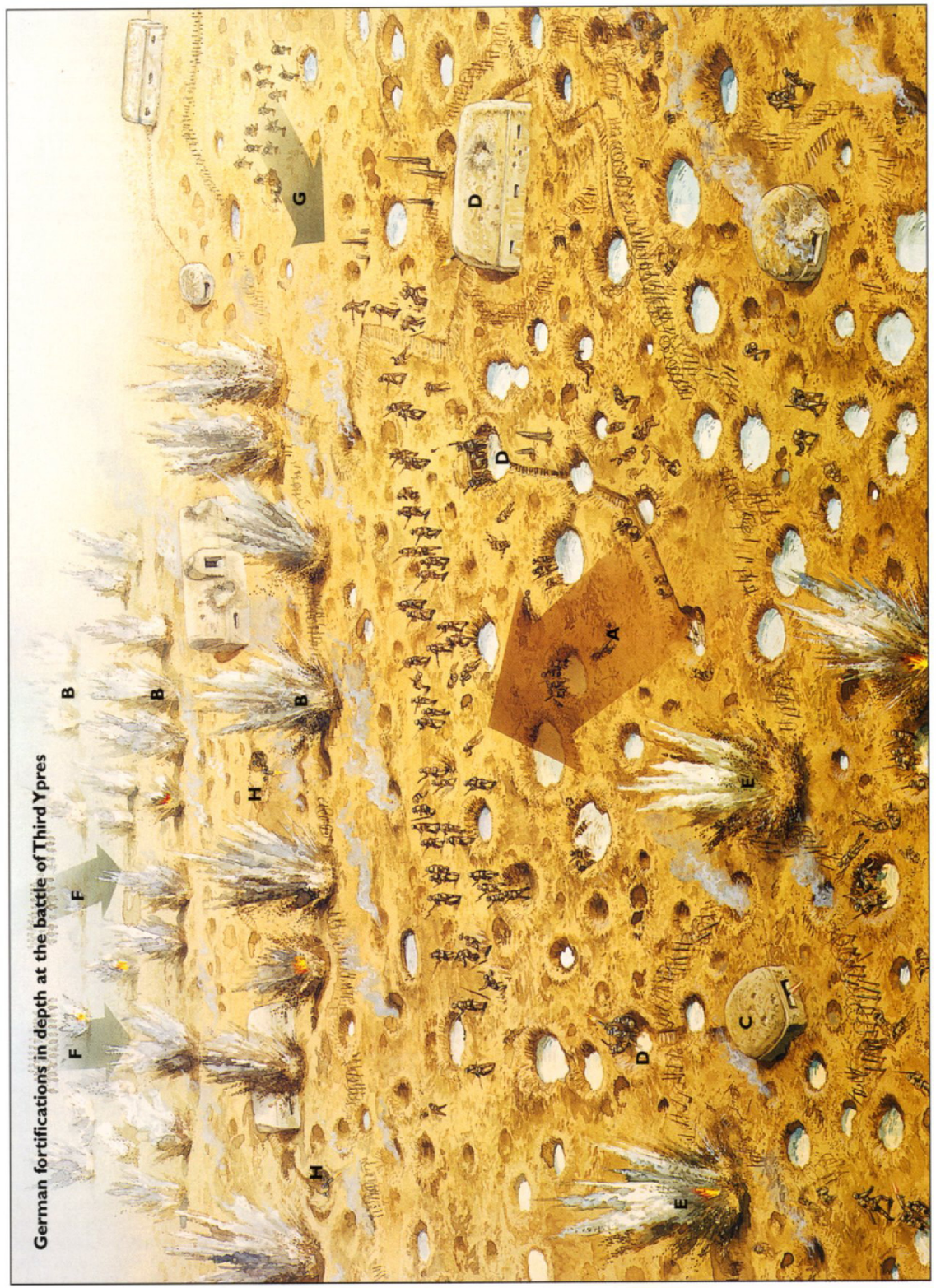
How to deploy the German Lochmann rapid wire entanglement. This was a net 13ft wide and 165ft long which could be carried in a 40in. diameter roll by six to eight men. It was to be supported by 120 screw pickets and could be laid very quickly as a basis for further entanglements. (Museum of the Queen's Lancashire Regiment: *The construction of field positions (Stellungsbau)*: British May 1917 translation of a German manual of June 1916 – p. 49, Fig. 61)

A French trench-digging machine in Champagne, 1916. It is perhaps remarkable that this type of technology was not used more widely, nor given more funding for technological development. If it had received even 10 per cent of the resources devoted to the tank, for example, the whole scale and depth of fortification on the Western Front would surely have been totally transformed. (Imperial War Museum, Q 75984)

comfortable billets might be found in schoolrooms, large farm buildings or even from time to time, it must be said, in the proverbial chatêau.

b) 1917–18

In the battle of the Somme the Germans suffered what they saw as unacceptably heavy losses not only in manpower, but also in terms of ground and in the military initiative that had always been a key principle of their staff planning. They were desperate to find a better way of doing things, so for 1917 they changed their approach and introduced a new concept of elastic fortification in much greater depth than hitherto; not only in their new Hindenburg Line but also elsewhere. Historians have usually hailed this system as a great improvement, and it is true that it could claim a number of dramatic successes, most notably on the *Chemin des Dames* in late April and at Cambrai from 30 November, when almost all of the ground lost to an initial allied attack was quickly recaptured. Elsewhere, however, it can be argued that the overall results of German defensives in 1917 showed little tangible improvement over their record in 1916. The allies had certainly made great progress in delivering a successful punch on the first day, and we may speculate that if only the type and scale of attack that was actually made at Ypres on 31 July 1917 could have been made on the Somme on 1 July 1916, then Bapaume would have been captured by 3 July, and Haig would have been hailed as a new Napoleon! Equally, the Germans never did seem to recapture very much of the ground they lost, apart from the two spectacular exceptions already mentioned. During the middle phase of Third Ypres they tried a number of experiments in siting major counter-attack forces more or less close to the front line; but in no case were they particularly successful, and in some cases they met total disaster. Nor were their trenches always the highly crafted masterpieces that their opponents often imagined. One engineer report on the operations of 8–9 June 1917 said that 'The enemy dugouts seemed no better built than ours. His front line is in a very much worse state than ours, and is just "V" shaped, and with no revetment and no duck-boards.' Overall, therefore, the Germans still continued to lose men, ground and military initiative no less than they had done on the Somme, and they must have begun to suspect that their 'new defensive techniques' amounted to little more than a case of running to stand still.

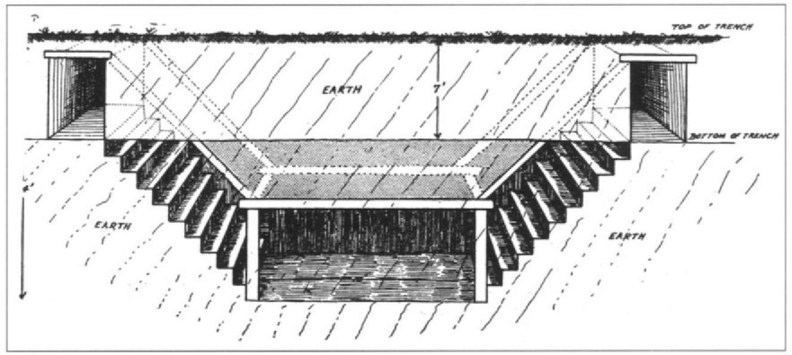


German fortifications in depth at the battle of Third Ypres (diagrammatic and not to scale)
In stark contrast to the hard uncratered chalk at Cambrai (see pp. 30–31), the terrain around Ypres consisted of clinging, bottomless mud, which had been subjected to years of shelling. Trenches or dugouts could not easily be kept drained, with the result that 'communication trenches' were no more than duckboard tracks, while 'strongpoints' were normally built of concrete, above ground, or were simply flooded shell holes connected by shallow ditches. The physical appearance of the defences was thus very different from that of the classic Hindenburg positions around Cambrai, even though the two battles were both fought in the autumn of 1917. At Ypres the German defenders had been well warned of the impending attack, and they planned to blunt it on their front-line pillboxes, and then repulse it by local or higher level counter-attacks. It was always a feature of every German defensive system that mobile elements would be commited as early as possible to hit attackers while they were still disorganised by their own advance.
A) Main thrustline of British attack.
B) Successive lines of the British creeping barrage, which might cover an area 2,000 yards from front to rear. The idea was to suppress all enemy troops who might otherwise be tempted to fire against the attackers.
C) A pillbox surrounded by wire, which has survived the creeping barrage. It holds out against the attacking British infantry who are attempting to suppress it with their own platoon weapons.
D) Bypassed German units emerge from cover, behind the assaulting troops, to engage them in the rear. The difficulty of movement in this sodden terrain made it particularly tricky for attackers to search out every funk-hole in which enemy soldiers might be lurking.
E) German counter-barrage being fired in support of their unsuppressed pillbox.
F) Major German counter-attack, probably doomed to destruction in the face of massed British artillery. The Germans never really found an answer to this threat.
G) A local German counter-attack from a flank, which might have a better chance of success due to its speed and unexpected direction.
H) German machine guns posted in shell holes, with only rudimentary mud paths in place of 'communication trenches'.

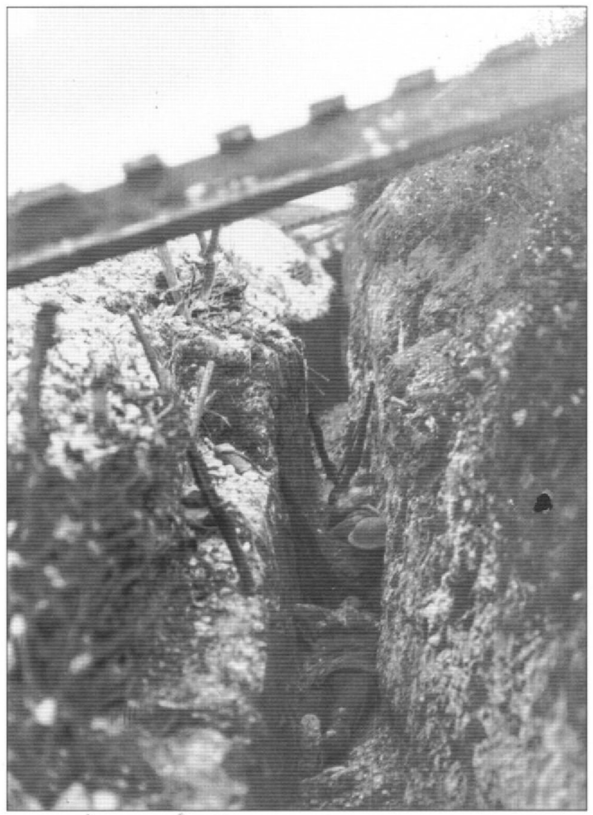
Having said all that, it remains true that after the 'first days' in their 1917 battles the allies still seemed to make no better progress in their follow-throughs than they had in 1916. They could not move their guns, supplies or signals forward fast enough to exploit each success, and the defender could always apparently improvise a minimum defence far easier than an attacker could organise a new formal attack to cut through it. To the attackers this was inordinately frustrating, and they doubtless leapt too quickly to the conclusion that the cunning German strategy of 'defence in depth' was a real revolution, especially since this was precisely the message announced by captured German General Staff manuals that were then translated and disseminated to the allied troops. On the ground, however, it must remain debatable whether the average German infantryman could notice any particular difference between the 'bad old' way of retreating uphill from Fricourt through Bazentin to High Wood in the autumn of 1916, and the 'fantastic new' way of retreating uphill from Potije through St Julian to Passchendaele in the autumn of 1917.

For spring 1918 the Germans had clearly lost patience with all this nonsense, so they changed their whole approach yet again; this time by reverting to the offensive. Meanwhile the allies took a precisely opposite view and tried to lay out their own defensive lines 'in depth', attempting to copy the scheme described in all the best captured German manuals and also, incidentally, undertaking their first major programme of pillbox building. But due to a distressing number of political, personality and intellectual failings, this gigantic piece of military plagiarism turned out to be a particularly dismal failure, not least in the British 21 March defeat at St Quentin. On that occasion Gough's Fifth Army seemed to be applying only the very worst features of both a 'strong first line' backed by a 'hasty or improvised defence for semi-mobile warfare', and all in a fog of morning mist that negated any useful communication between the front-line infantry and its artillery! The whole lot was overrun in quick time, in what must stand as a classic example of the 'how not to do it' school of defence in depth.

In the 'pure' 1917 German concept of elastic defence the first or 'outpost' zone would be some 500–3,000 yards deep, with an essentially screening or



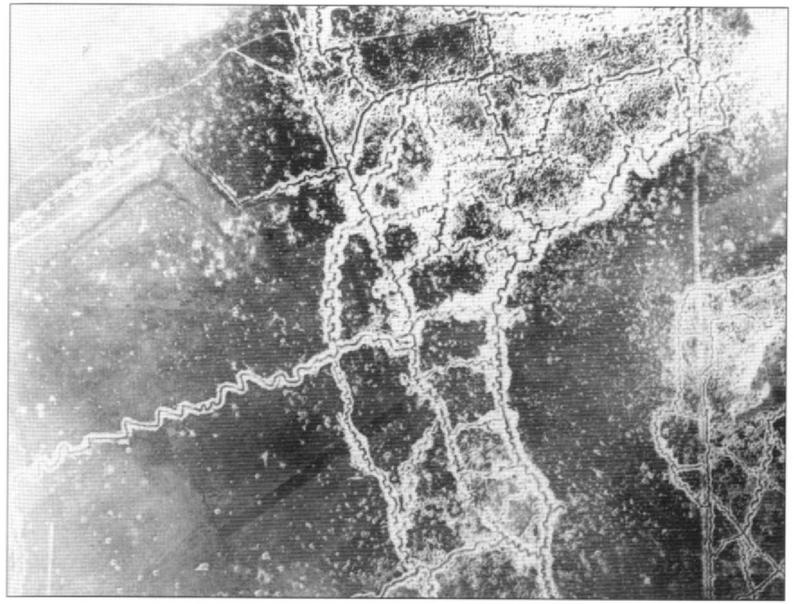
Design of a German dugout as captured by the French in June 1915, and now recommended to the British as 'undoubtedly the best'. This one has a floor about 19ft below ground level, but they became deeper as the war progressed. (Museum of the Queen's Lancashire Regiment: *Western Command Notes from the front, Jan 1 1916* – Sketch 5)



Troops asleep in support trenches with duckboard bridges near Beaumont Hamel at 7am on 1 July 1916. Note how deep and narrow these trenches are, since they are not for everyday living but simply for the temporary needs of troops about to move off into the front line. (Imperial War Museum, Q 60)

'skirmishing' task. It would be heavily wired, but would contain relatively few men. There would be the most forward artillery observers and sufficient scattered machine-gun posts, snipers and wiring parties to offer a full defence against raids and other hazards in normal times; but as a German directive of 1 December 1916 had said, the idea was to 'hold this very very lightly'. If the enemy wanted to attack, he would have to use the full panoply of a set piece attack with all the trimmings: but if this did happen, the garrison of the outpost zone would find it had been allocated an almost sacrificial role. It would collect the whole weight of the attacker's initial barrage – which would have been lovingly planned for weeks before – and there was every chance that the assaulting infantry would quickly overrun the entire zone, as they did on the first days at Arras, Messines and even Third Ypres itself. Few inhabitants of the outpost zone could realistically hope to escape death or capture during the first day or two of such an onslaught. Yet from the point of view of the German high command they would have achieved the vital function of blunting the attacker's main punch. His all important first day's barrage would have fallen on barren ground, and would not have touched the defender's main zone of defence. Not only would his massive initial load of shells have been wasted, but he would then have to relocate the bulk of his artillery and logistics to new, unreconnoitred and improvised positions at very short notice. His next attack, which would be against the defender's main battle zone, would have to be extemporised rather than deliberate, or in General Staff terms he would have lost the military initiative ... and therefore probably the battle as a whole.

Behind the outpost zone came the main battle zone – from 1,000 to 3,000 yards deep, although in later days it would tend to be even deeper. Obviously the exact depth was determined by many variable factors, such as the resources available and the lie of the contours. The latter was always of particular importance to the German tacticians of 1917 as they tried to deepen the battlefield not only in physical but also in psychic terms, by hiding its main features behind crestlines. The whole concept was to disappoint each of the attacker's expectations in turn. After he had wasted his initial bombardments,



Aerial view of trenches between Loos and Hulluch July 1917. Note how the majority of shell craters are concentrated on the trenches running parallel with the front, rather than on no man's land or the communication trenches running to the rear. This demonstrates considerable accuracy on the part of the gunners. (Imperial War Museum, Q 45786)

he would be lured forward into terrain he did not know and fragmented between a web of strongpoints he could not see, at least until he had spent some time taking his bearings (and asking for new aerial photographs). The defender could then exploit this time of confusion by making counter-attacks to recapture the strongpoints he had lost. From the perspective of the German high command the ideal situation by the end of the second or third day would be to find most of the attacker's spearheads enmeshed and enmired deep within the main defence zone, and visibly wilting under a variety of fire and counter-attacks from all directions.

Behind the main battle zone came a relatively empty space, which would initially be occupied by machine-gun posts and the shortest range artillery. Then came a rear battle zone of similar depth to the first. Both of the battle zones consisted of mutually supporting but tactically free-standing strongpoints, although they might be physically connected by communication trenches. Such trenches would also assist the movement of the various counter-attack platoons, companies, battalions and even divisions. The further

Duckboard track to a concrete blockhouse at Zonnebecke, Ypres, 30 October 1917. With the high water table and destruction of drainage systems in this area, communication trenches became impractical and could be replaced only by duckboard tracks like this. The main criticism is that the BEF's engineers often failed to provide enough of them. (Imperial War Museum, E 1213)

to the rear it was posted, the stronger each counter-attack force was likely to be, with a complete *'Eingrief'* division being held in reserve well behind every two divisions in the battle zones. In theory, each of the counter-attack elements was intended to return to its original post after it had restored the line, although in practice this concept was observed more in the breach than the practice.

Behind the rear battle zone came the main artillery line, supported by one machine-gun marksman brigade (of 15–20 guns) per division, as well as whatever infantry units were in the process of moving forwards or backwards according to the normal system of reliefs. Finally, and some way behind the area of the battle, there was the assembly area for the *'Eingrief'* divisions, through which all other additional reinforcements might also move towards the front, with pre-planned roadways to carry them.

Such, then, was the basic concept for the German defensive battles of 1917. It was applied on a grandiose scale at all the points that seemed to be threatened, although by the end of Third Ypres the scale had been reduced from whole divisions holding the battle zones, with additional troops behind them, to just a regiment for all functions. Thus on 10 November at Passchendaele the Germans held each section of front with one battalion in the main line of resistance, one in the rear line and the third in reserve. The total depth of each regimental position was little more than two miles, which represented a much more compact battlefield than some of the layouts planned earlier in the year, and in some ways almost a reversion to the methods used on the Somme in 1916.

British depth defences, March 1918

Over the winter of 1917–18 General Gough's British Fifth Army outside St Quentin was over-extended and undermanned. It made an attempt to imitate German methods of flexible defence in depth, 'as at Ypres', using detached strongpoints and counter-attack detachments rather than continuous lines of trenches for static defence. In theory there was supposed to be an outpost line, a main battle position and a reserve or rear battle line. Unfortunately, however, the resources and time needed to complete this ambitious scheme were not available before the Germans launched their major offensive before dawn on 21 March. Only the front line was manned – and in many cases over-manned – whereas the main and reserve lines were badly under-prepared for combat. This allowed the German spearheads to infiltrate behind the front positions and press their exploitation further to the rear, especially since the terrain in this sector was far more open and less spoiled by cratering than at Ypres, so an attacker could make rapid progress. Another advantage that the Germans enjoyed was a heavy morning mist (not shown in the illustration!), which concealed the movements of their infantry and, more importantly, prevented the defending artillery from seeing the SOS rockets fired from the British front line. In many cases the British guns scarcely fired at all. By contrast the German hurricane bombardment, which reached back through the entire depth of the British defences, had a paralysing effect.

A) Company-sized strongpoints or 'keeps' in the front line, which were particular targets of the attack.
B) Signal rocket fired in vain to bring down defensive artillery fire, after the German bombardment had cut the telephone cables. The gunners were unable to see the rockets through the mist that covered their positions.
C) British brigade HQ position in the main battle line, complete with a deep bunker and comfortable amenities such as a well kept garden and a variety theatre – but no effective defences.
D) Artillery lines to the rear, out of touch with the course of the battle.
E) British reserve battalions unprepared for combat and not dug in.
F) Planned but unfinished strongpoints in the main and reserve lines.
G) Planned trenches dug only 2ft deep.

British depth defences, March 1918

Aftermath

In the aftermath of the armistice on 11 November 1918, the first priority in the '*zone des armées*' was to rebuild the shattered villages and fields and then, before very long, to plant them with hundreds of neatly laid out cemeteries and monuments. As far as 'The Art of War' was concerned, the next development after that was the building of the Maginot Line (see Fortress 010: *The Maginot Line 1928–45* by William Allcorn, Osprey Publishing Ltd: Oxford, 2003) on the newly restored Franco-German border, as well as certain other modern concrete forts designed to protect Holland and Belgium from any further German aggression. Clearly nothing had happened in World War I sufficient to persuade governments that such works had become obsolete, although Fort Eben Emael on the Albert Canal will be best remembered by historians because it was so spectacularly captured on 10 May 1940 by two innovative new technologies: not only airborne envelopment, but also the use of shaped charges by assault pioneers to pierce thick concrete structures.

As far as fieldworks are concerned, the experience of World War I was generally accepted as the ultimate peak to which the art could possibly attain, and it was enshrined in the manuals of all the armies concerned: for example, the British *Manual of Field Works (all arms)* of 1925 essentially repeated the same advice as had its predecessors of 1917–18. The result was that when it came to the next world war in 1939–45, almost all of the practices used in 1914–18 were pretty well repeated verbatim. The main new addition was a burgeoning carpet of contact mines, both anti-tank and anti-personnel, which perfected the hesitant initial experiments seen in the earlier conflict. There was also an increased emphasis on personal slit trenches and foxholes, with correspondingly fewer deep shelters for large-scale occupancy, which was perhaps coincidentally accompanied by a general lightening of the weights of shell being used by the heavy artilleries. It nevertheless remained true that long sequences in the Spanish Civil War, World War II and the Korean War were fought out as trench stalemates, and with several continuous lines of trenches deployed in depth, very much on the model of the Western Front in 1914–18. Indeed one major US endeavour in Korea was codenamed 'Operation Killer', because it was designed specifically to maximise the attrition of enemy manpower. After Korea the wars tended to be less formal and set piece, with greater emphasis on light or guerrilla forces. Nevertheless, the siege of Dien Bien Phu in 1954 was a highly conventional trench battle, while the notorious tunnels of Cu Chi in the late 1960s must have been more than a little reminiscent of the *Hangstellung* of the Hindenburg Line.

The sites today

Essentially the battlefield sites on the Western Front today come in four types:

1) The **cemeteries and monuments**, almost all of which were built after the war, and which therefore need not concern the modern student of the war itself, unless it is for purposes of family remembrance. Note, however, that some of them do actually include original fortifications, for example the concrete shelters in the German cemetery at Langemarck and in the British cemetery of Tyne Cot, which includes one that is 98 per cent buried under the central pure white stone cross of sacrifice.

2) The **fields, woods, villages and contours** that originally shaped the layout of fortifications and tactics in 1914–18 were speedily and lovingly restored after the war to more or less their original pre-1914 form. We can only admire the skill and energy of the good people who did it. They have allowed us to re-visit the battlefields in at least a distantly recognisable form, and to understand many of the intricate terrain relationships that determined the course of the fighting. It should nevertheless be mentioned, alas, that in the process they have often buried or destroyed a good proportion of the archaeological evidence for the trace of the fortifications, as well as many of the fortifications themselves. It is only in a good light at certain times of the year, and often only from a light aeroplane, that a comprehensible pattern of the trench lines is revealed from below the surface of the ploughed fields. There are also some significant areas that remain inaccessible to the view of the modern tourist, because they are either privately owned woods, or have been built over by modern suburban sprawl.

3) The **above-ground fortifications** that survive may be found either where they have been deliberately preserved as monuments, or where no one has seen any particular reason to remove them. Most of the pre-war forts are still there and are by far the most spectacular examples of 1914–18 fortification that can be visited, even though they are usually in a distinctly battered state, and often in the notorious 'private woods' (a surprisingly large number of which are still owned by the army), which make them inaccessible. At Verdun, forts Douaumont and Vaux are open as tourist attractions, as is the original Vauban citadel and some of the lesser batteries; but that makes only a fraction of the 20 forts dotted around the area, not to mention many more that defend the right bank of the Meuse all the way down to St Mihiel, Toul and the Charmes Gap. A few other forts are open to the public elsewhere, such as Fort Pompelle near Reims; but the remaining majority must be approached in the spirit of one who enters a dense and trackless jungle of brambles in which man-made 30ft cliffs may open beneath one's feet without warning at any time. Nor, indeed, is it unknown to encounter dangerous items of unexploded ordnance.

In the case of concrete pillboxes, probably the majority were either destroyed in the fighting or later demolished and removed from the landscape; but by their very nature the task of demolition is an onerous one, and far less straightforward for the landowner than simply ploughing over a trench. A large number of pillboxes may therefore still be found, incongruously lurking beside a farm midden or brooding over an empty field.

Sometimes their roof is flush with ground level, while in the case of Hussar Farm at Potije the concrete British observation post peeps out above a two-storied farm building. Thus a wide representative sample of the structures that were built may still be inspected, although very few have been made into

Original German block-built concrete shelters preserved in the German cemetery at Langemarck, Ypres. (Paddy Griffith)

tourist attractions. Most British tours to the Ypres salient seem to look at the German concrete machine-gun post on Hill 60, which was then 'turned round' for British use; although it may well be that Colonel Driant's command post just behind the original French front line at Verdun (a particularly early example of a concrete fieldwork) attracts more visitors each year.

When we come to the trenches themselves, which were surely the preponderant type of fortification in this war, we find that all too few have survived in any recognisable form, and still fewer have been consciously preserved. Nevertheless, some do remain as memorials, with concrete-filled sandbags to help them endure for the long term, for example, those of the Belgians at Stuivenkenskerke near Dixmude; of the Canadians at Vimy Ridge; and (with rock-walled rather than sandbagged trenches) of the French on the summit of Le Linge in the Vosges. There are others that have not been concreted but which are open to visitors, as at Newfoundland Park at Beaumont Hamel, Belleau Wood near Château Thierry or Navarin Farm east of Reims. Elsewhere there are a number of trench sites that have been partially maintained, although dark rumours persist that in some places new ones are still being dug to enhance their attraction to tourists! However that may be, it is very often possible to find the silted-up remains of genuine trenches in wooded areas away from the beaten track, where they have not been ploughed under the fields.[2] Since 1918, for example, much of the Verdun battlefield was given back to nature, with the result that large sections of it are wooded today and very difficult to interpret, although with a little persistence one may still discern the trench lines snaking around beneath the undergrowth. Much the same applies to shell craters (although it is often difficult to decide just which holes in the ground in the middle of a wood were caused by HE bombardment, and which by the later uprooting of trees falling over in storms). When looking at shell craters it is always instructive to note their size and the distances between them. Thus at Newfoundland Park the craters caused by German fire in 1916 are relatively small and dispersed, whereas those at Vimy Ridge, caused by allied fire in 1917, are deep and overlapping. There is thus a clear difference between the two sites in terms of the intensity of the shelling that fell upon them.

[2] Using the same approach, many practise trenches of 1914–18 may still be discerned in military training areas where the land use has remained unchanged since 1914. Among others, the Aldershot area in England is dotted with such historic earthworks.

Trenches in the museum at Sanctuary Wood, Ypres, in modern times. Although these fieldworks have been made neat and pretty for the tourist, they were probably not very much deeper or safer for the soldier in World War I than their present form would suggest. A man standing in them might not have had protection for his head. (Paddy Griffith)

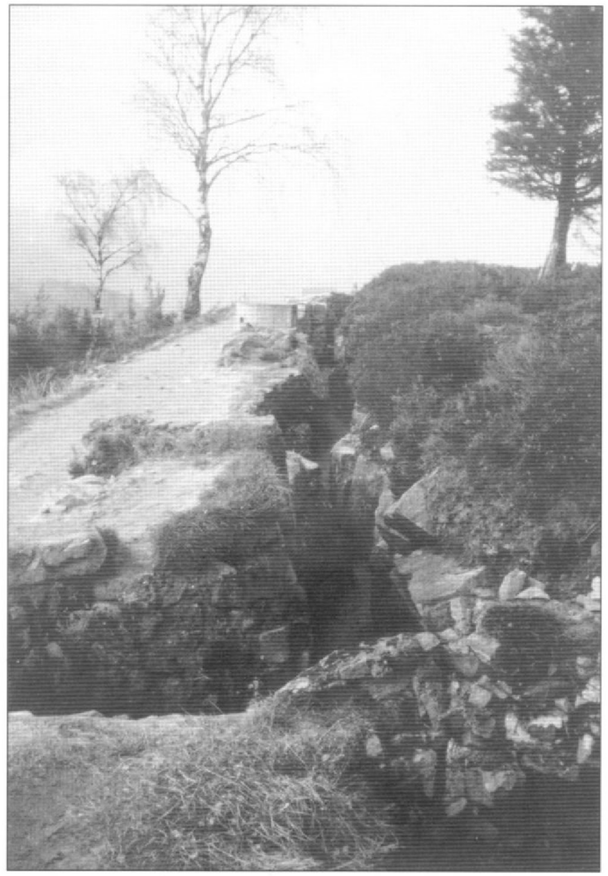
4) Finally, if you wish to inspect **deep dugouts or other subterranean works**, there are few options open unless you are a professional archaeologist. In recent years great restrictions have been placed upon the excavation of such sites, and digs are usually organised only on an emergency basis, where there is subsidence or where new building projects threaten known works. The task of excavation is already difficult enough because the dugouts are by definition buried and by now often suffering from flooding or cave-ins; but it was made doubly so in the 1920s when many of the timbers, particularly those most accessible at the entrances, were plundered by local builders for use in the reconstruction. This often had the effect of collapsing the entrances and so hiding the location of the dugouts, which in turn rebounded on local people who later built houses on top of them, only to find a devastatingly high incidence of subsidence. The whole subject of subterranean works and their archaeological investigation, including mines as well as the evolution of deep dugouts, is authoritatively explained in the new book by Peter Barton and Peter Doyle.

Although the vast majority of sites are now inaccessible, there are nevertheless a very few subterranean works that may be inspected by the general public, such as the *Caverne du Dragon* near Craonne on the *Chemin des Dames* (which at one time in 1917 was an uneasy sanctuary for both sides at once!); the Arras city catacomb, and the mine tunnels under Vimy Ridge, the un-flooded levels of which are maintained by the Canadians. The Riqueval canal tunnel north of St Quentin may also be visited, but it has now reverted to its orginal purpose and shows few signs of its German occupation as a shellproof dormitory in September 1918.

Some starting points for fortification tourism on the Western Front

Beaumont Hamel: Newfoundland Memorial Park is a section of the Somme battlefield essentially untouched since the Newfoundlers made their sacrifices there in 1916. It is on the road to Auchonvillers about 3km north-west of Hamel, which is 7.5km north of Albert by the D50 road (Department of the Somme). Monument et Parc Commémoratifs de Terre-Neuve, Rue de l'Eglise, 80300 Hamel, France.

La Caverne du Dragon at Hurtebise (4.5km up the D895 road west of Craonne, Department of the Aisne – some 22km south-east of Laon), is an



Reconstructed stone-built French trenches near the crest of the Hartmannswillerkopf in the Vosges, halfway between Munster and Thann. There was intense fighting here in January, April and October 1915, after which it became a 'quiet' front. Not shown are the concrete pillboxes which later added strength to the complex. (Dr Geoffrey Noon)

enormous underground complex that has been greatly opened up to visitors in recent years. D18 'Chemin des Dames', Oulches la Vallée Foulon, 02160 Beaurien, France.

Le Linge: Scene of a fierce battle in 1915 on the summit of the Vosges. The preserved trenches are about 7km north up the D56 road from a point halfway between Stosswihr and Munster (17–22km west of Colmar), Department of Haut Rhin. Correspondence to Mémorial du Linge, BP 173, 68003 Colmar Cedex, France.

The Sommepuy (or Blanc Mont) American monument, 4.5km north-north-west of Sommepuy-Tahure just west of the the D77 road (about 40km east of Reims, Department of the Marne) is surrounded by original – but not artificially preserved – trenches, as is the Ferme de Navarin memorial, 3km south of Sommepuy-Tahure on the D77.

Stuivenkenskerke: The 'Boyau du Mort' (trench of death) is a concrete-preserved Belgian trench system overlooking the Yser river/canal about 2km north-north-west of Dixmude (23km north of Ypres, Flanders), including some original works. Yserdijkt 65, 8600 Diksmuide, Belgium.

Vimy Ridge: Approach the Canadian National Memorial either by driving north up the D55 from Neuville St Vaast (crossing the motorway), or by going west from the N17 at Vert Tilleul, 1km south of Vimy village or 10km north of Arras (Department of Pas de Calais). The memorial park includes a vast area of (not artificially preserved) trenches, shell holes and mine craters, as well as a neat group of trenches which are preserved with concrete-filled sandbags. Not only that, but there is also an extensive network of mine tunnels, including Grange tunnel which may sometimes be visited. Monument et Parc Commémoratifs du Canada, 62580 Vimy, France.

Verdun (Department of the Meuse): Fort Douaumont and Fort Vaux offer splendidly rewarding sites for the visitor, both above and below ground; as does Colonel Driant's HQ bunker, and many more defensive works besides. Drive 4km up the D112 out of the north-east side of Verdun city then at the summit turn right onto the D913 for forts Souville, Tavannes and Vaux: then return to the crossroads and go straight ahead for a surfeit of monuments – but more importantly, Fort Douaumont. Go back west-north-west for 6km down the D913 to Bras: turn right 62km for Vacherauville, thence 6.5km north-west up the D905 to the Driant monument and battle HQ bunker. Further details from the Verdun tourist office, Place de la Nation, BP 232, 55106 Verdun, France.

Ypres area: Hill 60 and Sanctuary Wood, some 6km south-east of Ypres (Flanders), each boasts a private museum close beside some trench sites. Hill 60 is 1.5km south of Zillebecke, on a side road between Verbranden-Molen and Zwartleen (just east of the railway). Sanctuary Wood is up Maple Avenue, which is a cul de sac leading to the Canadian memorial on Hill 62. Find the entrance to the Avenue off the south side of the Menin Road at the foot of the slope about 0.5km west of the Hooge military museum. Further details of the Ypres area from the Visitor's Centre of Ieper and the Westhoek, Lakenhallen (Cloth Hall), Grote Markt, 8900 Ieper, Belgium.

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Glossary

Aerial torpedo: a shell filled with Melinite (i.e. a French form of HE).

BEF: British Expeditionary Force.

***Béton* (French) or *Beton* (German):** concrete.

***Béton Armé* (French):** reinforced concrete (i.e. with steel rods incorporated in the structure)

Blockhouse: originally a strong building or sheltered part of a barracks. In 1914–18 it was used loosely for any dugout with shell-proof cover or especially any concrete structure.

Bunker: a living space with shell-proof overhead cover, often made of concrete.

Camouflaged trench: a trench covered by camouflaged canvas sheets to conceal it.

Communication trench (or 'CT'): a trench built at 90 degrees to the front line through which men and supplies can pass from the logistic rear to the front-line trench.

Corduroy or Cord: treetrunks, telegraph poles, planks, fascines other timbers laid across a gravel- or hardcore-graded track to allow traffic to pass without bogging in.

CB: counter-battery (i.e. action designed to destroy enemy artillery).

Counter-scarp: a vertical (usually masonry) wall, sometimes up to 30ft high, on the enemy's side of a fortress ditch: less vulnerable to fire than the 'scarp' which faced the enemy.

Deep dugout: as its name suggests, a British '*Hangstellung*'.

Duckboard: wooden decking or 'board walk' to allow troops to walk over wet or boggy ground (eg at the bottom of a trench) without sinking into it. In the rainy seasons at Ypres the only practicable paths across the battlefield were made with duckboards.

Dugout: an underground living space with shell-proof overhead cover.

Dummy (or 'Chinese') trench: a false trench created by the skill of the artist on a strip of canvas, to deceive enemy air photography. Used e.g. by 9th Division at Meteren, 1918.

***Eingreif* (German – literally 'Intervention'):** name given to German counter-attack divisions.

Fascine: a tightly bound bundle of brushwood or other sticks used to fill up a trench or pave a cord road, to allow trafficability. Cf the 'fasces' of ancient Rome had been symbols of state discipline, since the sticks had been used to beat malefactors (hence the modern word 'fascist').

***Feste* (German – literally 'stronghold'):** a wide locality carefully prepared for defence on the inner French border before 1914. They were essentially equivalent to fortresses but included several dispersed batteries rather than a single central ditched work.

***Fort d'arrêt* (French – literally 'Stopping fort', but perhaps better translated as 'Spoiling fort'):** an isolated outpost to plug one of the gaps planned in the Serré de Rivières system.

Flying sap: a trench dug in a single night, ie before the enemy knows where it is.

Fougasse: a hole full of stones or other shrapnel with an explosive charge beneath them, to be activated (by various means) when enemy troops are in the area. An early version of the modern claymore mine.

No. 106 Fuse: British fuse for an HE shell, intoduced in 1917, which detonated the shell immediately on contact with the earth, instead of after the shell had buried itself, as had been the case with earlier fuses. This allowed a wider lateral spread of the explosive effect, which was much more destructive not only to men, but eg to wire entanglements.

Gorge: the back wall of a fortress, facing away from the enemy.

***Hangstellung* (German):** a deep shelter used as a dormitory, such as those built into the Lens (or east) side of Vimy ridge. The use of railway or canal tunnels for similar purposes was also commonplace wherever they could be found.

HE: high explosive.

Keep (or Redoubt): a set of fortifications entirely surrounded by a parapet, giving all-round defence. Normally located in depth behind a front line, but sometimes in the very front, e.g. 'Manchester Hill', which took the initial shock of the March offensive 1918.

MEBU (German: *Mannschafts-Eisen-Beton-Unterstand)* or *Panzer-mebu*: a reinforced concrete shelter for troops: normally a pillbox or other tactical blockhouse, but possibly also a '*stollen*'.

Mine: In traditional military parlance this was both a tunnel dug forward under the enemy's defences (by 'miners') and the parcel of nastiness secreted at its far end, which in 1914–18 might consist of several tons of HE. Towards the end of World War I it also came to mean anti-tank devices attached to the pickets of a wire entanglement, which were contact detonated = the origin of the millions of contact mines deployed in World War II.

Parados: earth raised behind a trench to protect its occupants' backs against shell fragments.

Parapet: earth raised in front of a trench for protection against both direct fire and shell fragments.

Pillbox: a bunker or blockhouse; the word was often used for a machine-gun post.

Revetment: strengthening of the walls of a trench, to stop it collapsing. It was done with sandbagging, brushwood mats or hurdles, often strengthened by wires, pegs and stakes.

***Rideau défensif* (French – literally 'Defensive curtain'):** a line of mutually supporting forts in the Serré de Rivières system, e.g. between Verdun and Toul.

Russian sap: a 6ft 6in. sap dug towards the enemy some 2 to 3ft below ground level in timber frames (ie as a very shallow mine tunnel), allowing assault troops to advance at least part way across no man's land without being seen. They featured in the assault plan for the first day of the Somme. The medieval tunnels beneath Arras were used as communication trenches in this way, whereas on Vimy Ridge the Canadians dug new 'subways'.

Sangar (Hindi): Originally a circular parapet made of dry stone walling. In 1914–18 it came to mean any fortification dug upwards above ground rather than downwards into it, eg because of the high water table around Neuve Chapelle or Ypres.

Sap: A narrow trench dug by men ('sappers') working at the bottom and working sideways towards the enemy (in theory at a rate of 1ft 6in. to 3ft per hour, or 30ft per day), rather than starting on the surface and working downwards.

Scarp: the wall of a fortress ditch that faces the enemy, which he must climb. Cf the counter-scarp is the wall that faces away from him, which he must descend. In the fortress achitecture of 1871–1914 the scarp was often a gently sloping field, since any more sloping vertical wall would too easily have been destroyed by shell fire.

Shell scrape: the most minimal type of personal trench, rapidly dug only a few inches into the ground in the hope of enhancing protection against bullets or shell splinters.

***Stellung* (German):** a position – either a single trench or a whole system of defence.

***Stollen* (German – literally a tunnel or gallery):** used at Verdun for shelters close to the surface from which troops could launch an assault.

Trace: the ground plan of trenches or other fortifications, which might be marked out by tape on the ground, or even left as a 24in. deep 'trace trench' for later improvement.

Traverse: a buttress of earth between two adjacent sections of trench, to limit the effects of any shell burst or enfilade. Traverses gave the Western Front trenches their characteristic 'cogged' or 'crenellated' trace. The 1917 manual wanted each traverse to be 9–12ft long and extending at least 2ft in front of or behind the line of the original trench. Sections of trench between traverses should be 18–30ft long.

Trench-block: a makeshift obstacle that could be placed across a trench to prevent enemy raiders advancing along it. Typically a 'knife rest' made of a roll of barbed wire on a timber frame.

The kilometre-long tunnel built by the Royal Naval Corps in the dunes near Nieuport as a communication trench, or almost a 'Russian sap'. (Imperial War Museum, Q 51039)

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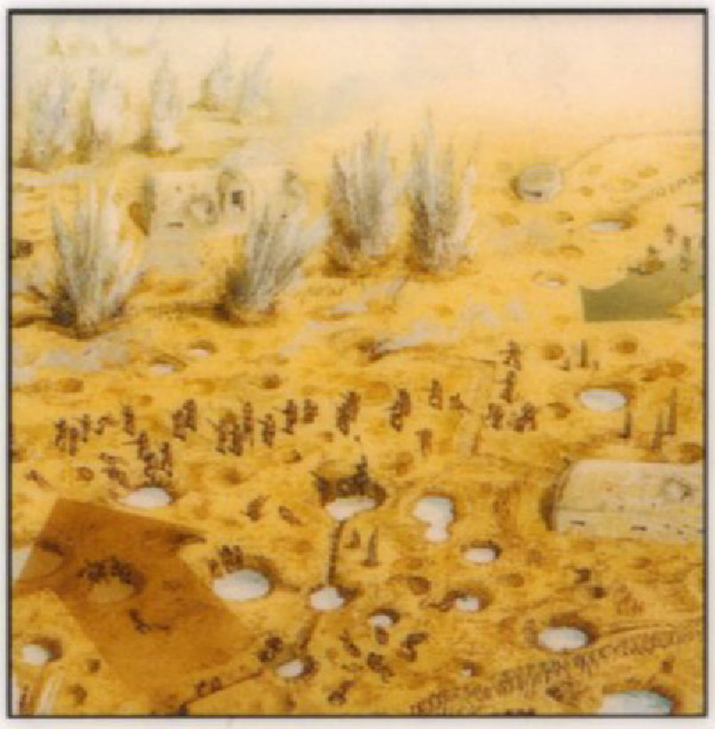
Design, technology and history of key fortresses, strategic positions and defensive systems



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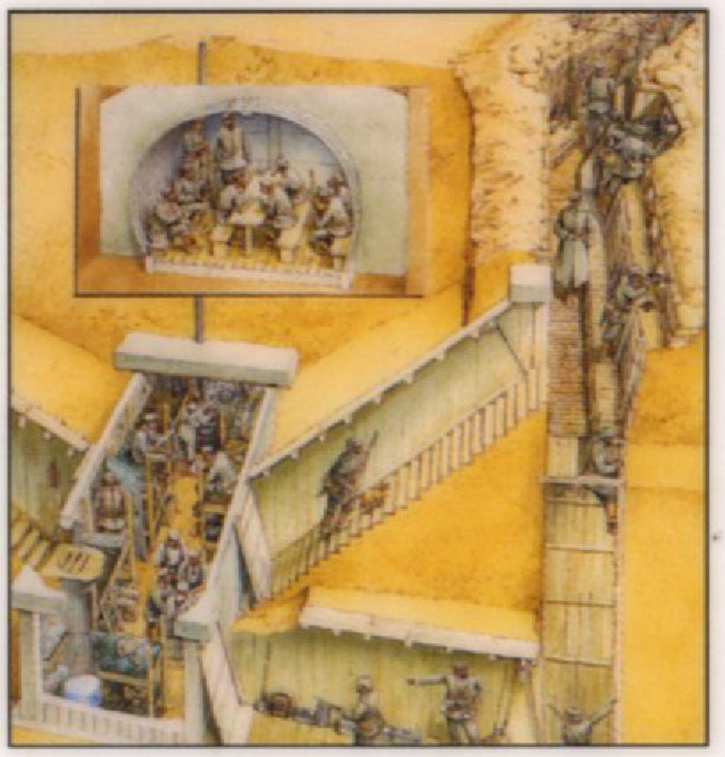

Cutaway artwork

Fortifications of the Western Front 1914–18

Following the early battles of 1914 along the Marne and in the Ypres salient, World War I rapidly changed from a war of movement into one of attrition, with the opposing sides entrenching themselves in a line of fortified positions from the Flanders coastline to the Swiss border. This volume details the different styles of fortification used on the Western Front throughout the course of the war, from the early ditches of 1914 to the complicated systems of 1918. It explains the development of the 'defence in depth' German approach and the British reaction to it, as well as illustrating the importance of the pre-war forts, particularly around Verdun.

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